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TWO SHARE PECORA AWARD

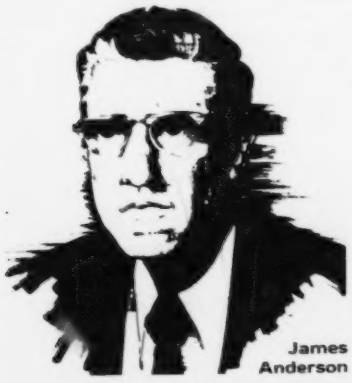
Nearly 300 geographers, natural resource managers, and cartographic, computer, and Earth scientists attended the 7th Annual William T. Pecora Symposium, in Sioux Falls, S. Dak., October 18-21, 1981. The theme of the symposium was "Remote Sensing: An Input to Geographic Information Systems in the 1980's." The Association of American Geographers (AAG), the National Council for Geographic Education (NCGE), and the American Society of Photogrammetry (ASP), sponsored the symposium in cooperation with the U.S. Geological Survey and the National Aeronautics and Space Administration (NASA). Proceedings will be available from the ASP in early 1982.

The symposia were instituted in 1975 in memory of the late Dr. Pecora to foster the exchange of scientific and resource management findings resulting from the use of remotely sensed data. A special Pecora Award is presented jointly every year by the Department of the Interior and NASA to honor the memory of Dr. Pecora who was Under Secretary of the Interior, Director of the Survey, and a leading figure in the establishment of the Earth Resources Observation Systems (EROS) Program and the EROS Data Center (EDC).

Two scientists credited with "outstanding contributions to the understanding of the Earth by means of remote sensing" shared the 1981 Pecora Award:

Dr. James R. Anderson, who died in December 1980, was honored posthumously for his work, which resulted in the first practical application of remote sensing technology to a national land use classification system. Prior to his service with the U.S. Geological Survey, where he was Chief Geographer and scientific advisor to the Director, Dr. Anderson performed landmark research with the Department of Agriculture and was a highly regarded university teacher and administrator. Until his untimely death, he was a leading figure in the planning of the 1981 symposium.

Leonard Jaffe, who held key positions for more than 30 years with NASA and its predecessors, was honored for being instrumental in the development of the Landsat Program. Under his direction, the "open to the public" data policy of the U.S. program was established. From 1969 through 1971, he held the NASA position of Deputy Associate Administrator for Space Science and Applications. He is currently vice president of Computer Science Corporation, Falls Church, Va.



James Anderson

Leonard Jaffe

NOTICE TO READERS

Because of problems encountered during production, the November 1981 issue of the Landsat Data Users NOTES was cancelled, causing a departure from our bimonthly publication schedule. Most of the articles that would have appeared in November are included in this issue. This is issue no. 21, and it is the next in sequence after last September's issue.

Landsat Data Users NOTES

ISSUE NO. 21
JANUARY 1982

NASA

U.S. GEOLOGICAL SURVEY
EROS DATA CENTER
Sioux Falls, S. Dak. 57198

I 19.78:

NEW CHIEF AT EROS OFFICE

John W. Salisbury was recently named the new Chief of the EROS Office. Dr. Salisbury comes from the Department of Energy where he was most recently the Acting Director of the Division of Geothermal Energy. Before his move to the Department of Energy 5 years ago, he spent 17 years with the United States Air Force Cambridge Research Laboratories. He achieved international recognition there as an expert in lunar and planetary research and remote sensing techniques. A geologist by training, Dr. Salisbury has authored more than 80 publications and received numerous awards for distinguished service throughout his career.

We extend him a warm welcome.

JOHN SALISBURY

PROPOSED FEE SCHEDULE FOR LANDSAT MSS DATA

The National Aeronautics and Space Administration (NASA) and the EROS Data Center (EDC) now recover only the cost of certain near-real-time services provided by NASA and the direct and indirect costs of data reproduction by EDC. This approach will change after the launch of Landsat D. The National Oceanic and Atmospheric Administration (NOAA), who will assume managerial responsibility for the U.S. civil land remote sensing system in fiscal year (FY) 1983, will recover the full cost of operating and maintaining the Landsat D program.

NOAA's goal of full recovery of the operating and maintenance costs of the Landsat D multispectral scanner (MSS) program includes meeting the direct, and associated indirect, costs of the following activities:

- Satellite command and control.
- Data acquisition and preprocessing at the NASA Goddard Space Flight Center (GSFC).
- Transmission of data to EDC or to those users who elect to use preprocessed data.
- Data processing and preparation of digital and imagery products for archiving.
- Retrieval of data from the archives and preparation of products for retrospective sale to users.

Thus, NOAA's costs will include all activities at GSFC, whether performed by NOAA personnel or support contractor staff; all direct and indirect costs at EDC; and all associated satellite communications costs.

Proposed Fee Schedule

NOAA has established fees for Landsat MSS data and data products, effective October 1, 1982, as follows:

- Data retrieved from the existing archives, or acquired by NOAA, as part of a Basic Data Set of worldwide MSS data:
  - Digital data at $650 per scene.
  - Imagery at an average of $47 per frame.
- Special acquisitions made at the request of the users:
  - Delivery of preprocessed digital data from GSFC via a communication satellite at $790 per scene.
  - Delivery of a frame of imagery from EDC at $880 per scene.
  - Delivery of a computer-compatible tape (CCT) or high-density data tape (HDT) from EDC at $1,000 per scene.
- Foreign ground station fees:
  - Annual access fee of $600,000 per station.
  - Distribution fee of $65 for each CCT and $5 for each photographic product sold or otherwise distributed by the station to customers.

A breakdown of prices for specific products and services is presented in tabular form below. Except where noted, the prices will apply to U.S.-produced data from all Landsat-series satellites (Landsats 1, 2, 3, and D).

LANDSAT PRICE LIST
(TO BE EFFECTIVE OCTOBER 1, 1982)

ARCHIVAL PRODUCTS:	Price
Photographic Products:	
70-mm Film Positive (B/W)	$ 26
70-mm Film Negative (B/W)	32
10-in. Film Positive (B/W)	30
10-in. Film Negative (B/W)	35
10-in. Paper (B/W)	30
20-in. Paper (B/W)	58
40-in. Paper (B/W)	95
10-in. Film Positive (color)	74
10-in. Paper (color)	45
20-in. Paper (color)	90
40-in. Paper (color)	175
16-mm Microfilm (B/W)	60
35-mm Slide (color), from existing collection	4
16-mm Microfilm (color, 100-ft roll)	150
Digital Products:	
9-track, 800-bpi CCT (MSS scene-all avail. bands)	650
9-track, 1600-bpi CCT (MSS scene-all avail. bands)	650
9-track, 6250-bpi CCT (MSS scene-all avail. bands)	650
9-track, 800-bpi CCT (RBV single subscene)	650
9-track, 1600-bpi CCT (RBV single subscene)	650
9-track, 800-bpi CCT (RBV set of 4 subscenes)	1300
9-track, 1600-bpi CCT (RBV set of 4 subscenes)	1300
14-track, High-Density Tape (variable content)	Variable
Generation of Color Composite (false-color infrared):	
Surcharge on product price	$ 195
SPECIAL ACQUISITIONS:	
(Special acquisitions signify Landsat D MSS scene data that are not scheduled for routine collection, but which are provided upon user request.)	
Delivery of preprocessed digital data to the requestor's site via communication satellite; per MSS scene collected at a time and place specified by the requester	$ 790

	Price
Delivery to the requester of a frame of standard MSS imagery (not a color composite); per MSS scene collected at a time and place specified by the requester	$ 880
Delivery to the requester of a CCT or HDT; per MSS scene collected at a time and place specified by the requester	$ 1000
Surcharge for delivery of a color composite to the user originally requesting the special acquisition of an MSS scene; per scene	$ 150
Surcharge applied when the requester establishes a maximum allowable cloud cover condition for the collection of an MSS scene; per scene	$ 250
SUBSCRIPTION SERVICES:	
Landsat MicroCATALOG:	
Annual:	
World (monthly update)	$ 1088
North Zone (monthly update)	508
South Zone (quarterly update)	290
Polar Zone (quarterly update)	290
Region 1 (monthly update	139
Region 2 (monthly update	139
Region 3 (quarterly update)	52
Region 4 (quarterly update)	29
Region 5 (quarterly update)	36
Region 6 (quarterly update)	36
Region 7 (quarterly update)	65
Region 8 (quarterly update)	52
Region 9 (quarterly update)	58
Region 10 (quarterly update)	131
Current Edition:	
World	377
North Zone	203
South Zone	102
Polar Zone	73
Region 1	58
Region 2	58
Region 3	17
Region 4	14
Region 5	14
Region 6	10
Region 7	14
Region 8	14
Region 9	14
Region 10	$ 36
Landsat MicroIMAGE Fiche (Landsat D): Annual by World, Zones, and Regions	Price to be announced
Landsat MicroCATALOG/MicroIMAGE Fiche (Landsat D) combination: Annual by World, Zones, and Regions	Price to be announced

NOTES:
1. 1 inch = 254 mm
2. BW = for "black and white"
3. bpi = bits per inch
4. CCT = computer-compatible tape
5. HDT = high-density digital tape

INTERNATIONAL CCT STANDARD

Concurrent with the launch of Landsat D, a standard worldwide format for computer-compatible tapes (CCT's) will become available.

This new format, adopted in 1978 by the Landsat Ground Station Operators Working Group (LGSOWG), was designed to facilitate the interchange of data between countries and to help lower overall software complexity and cost. It differs from current formats in that it carries an internationally recognized "superstructure" which provides comprenensive location and data description information on the tape itself. The superstructure concept allows the development of a "family" of formats which can include tape formats for a variety of data types, for example, image, polygon, profile, or point data. Once a user becomes familiar with the superstructure, it is possible, with any family member, to identify the data type and source, locate and read the desired data and support information, and in most cases directly apply the data to a given analyses requirement without software modification.

Formats adopt the superstructure through the addition of:

- A Volume Directory File, which generally describes the data configuration (in a Volume Descriptor Record) and provides pointers to each data file (File Pointer Records).
- A File Descriptor Record for each data file, which describes the data structure within that file.

The general format and content of these three records is similar; the purpose of each is to identify, describe, and locate data in the files to which they apply. The records of the Volume Directory File always equal 360 bytes in length; the File Descriptor Record assumes the same length as the records within the file it introduces.

The records within the data files themselves will be very similar in format to those of the current Landsat CCT format, but some minor differences will exist. One difference is that the record length for MSS data will be 3,600 bytes instead of 3,596 bytes. Another is that the location of some fields in the Landsat header record will be changed in order to have these fields fall on 4-byte boundaries. The actual content of the data records, however, will not change between the two formats.

The advantages of ready access to multisource data have encouraged the various organizations represented in LGSOWG, including EDC, to adopt the superstructure conventions for Landsat CCT's and to bring the formats of other Landsat processing centers into this family. Examples of data type formats other than Landsat which are already within the family include synthetic aperture radar data, imagery to be obtained from the French SPOT satellite, and Canadian geocoded polygonal data on natural resources.

An additional advantage of the superstructure convention is that it may be employed by users in recording reprocessed imagery, data resulting from image analysis (such as coded clusters), and associated information on the same (or a companion) tape. These kinds of secondary information are both documented and made accessible through the same superstructure conventions and software as in the original digital imagery.

To aid users in making the transition to the new International CCT Format, EDC has detailed documentation available on both the new format and on the philosophy of the superstructure approach. Requests for this documentation may be addressed to the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6151.

LATE PAYMENT POLICY

As directed by the Department of the Interior, the U.S. Geological Survey is required to charge interest on customer accounts not paid within 30 days of the billing date. Interest rates are determined by the U.S. Department of the Treasury on a quarterly basis. The annual rate for the period of January 1, 1982, through March 31, 1982, was set at 14.39 percent.

This policy will go into effect on April 1, 1982. EDC customers should be aware of it if they are currently carrying a delinquent bill for any products purchased. Questions can be directed to the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone (605) 594-6509.

Notice of any changes in the interest rate will be published in this newsletter.

REMOTE SENSING EXPERIMENTS ABOARD SHUTTLE

When the second Space Shuttle mission was carried out last November, a scientific payload known as OSTA-1 was aboard. This payload was developed by NASA's Office of Space and Terrestrial Applications (OSTA) to conduct experiments concerning the remote sensing of land resources, environmental quality, ocean conditions, and meteorological phenomena. Although the second Shuttle flight had to be cut back to a 54-hour minimum mission, most of the experiments obtained a sufficient number of observations to warrant terming the results successful. These are summarized here.

The **Shuttle Imaging Radar-A** (SIR-A) experiment used a side-looking, synthetic-aperture, imaging radar (the first to fly in space) to create two-dimensional images of the Earth's surface. An SIR-A type of sensor not only provides relief information but can also penetrate cloud cover and to some extent vegetation canopies as well. It thus holds much promise for geologic exploration.

All objectives of the SIR-A experiment on the second Shuttle were met. The radar equipment worked perfectly, and excellent image data (about 8 hours) were obtained over North and South America, Africa, Europe, and Asia. Several long passes over both the Atlantic and Pacific Oceans were also collected. The radar images gathered by SIR-A will be compared with other data, particularly Landsat images, to develop geologic information for locating hydrocarbons and mineral deposits. Radar imagery records differences in surface roughness and terrain attitude and therefore can be used to delineate faults, folds, domes, and drainage patterns. Landsat multispectral imagery will provide the supplementary information needed to identify rock and vegetation types.

The **Shuttle Multispectral Infrared Radiometer** (SMIRR) was also successful. This experiment was designed to evaluate the effectiveness of 10 spectral bands in the 0.5-μm to 2.5-μm range for discriminating geological units (rock types, for example) when the data are gathered from space. About 108 minutes of cloud-free observations were acquired. Although not yet analyzed, extremely good data are believed to have been acquired over Mexico and Spain; data acquired over the United States were of lower quality due to cloud cover.

SMIRR data will be correlated with field spectrometer data and with existing Landsat data to help determine spectral bands suitable for future orbiting multispectral scanners designed for geologic mapping. The variability in reflectance signatures of similar geologic units in different climatic environments will be assessed, and the effects of atmospheric absorption on the quality of the data will also be analyzed.

The **Feature Identification and Location Experiment** (FILE) was part of an effort to develop an onboard capacity to select scenes at the data gathering stage. Measuring spectral reflectances at the red (0.65 μm) and near-infrared (0.85 μm) wavelengths, it used a ratioing technique to determine whether given scenes contained vegetation, water, barren land, or clouds and snow. From the data gathered, a proof-of-concept for future "smart" Landsat-type satellites could be developed. The possibilities include automatic acquisition of data on certain surface features as well as automatic suppression of acquisitions when scientific objectives are not in view.

FILE acquired 32 hours of data. Some of these data, however, may have been lost because of marginal performance on the part of the sensor's tape recorder.

The **Measurement of Air Pollution from Satellite** (MAPS) experiment used a carbon monoxide detector to measure the relative amount of CO in the middle and upper troposphere. It also included an aerial camera to record cloud cover and terrain data. The performance of MAPS under various temperatures and other orbital conditions is expected to indicate the potential effectiveness of using orbiting spacecraft to measure environmental quality.

The experiment acquired 32 hours of data, including excellent sightings over Virginia, Florida, and California.

The **Ocean Color Experiment** (OCE) was designed to test the ability of a sensor to automatically map chlorophyll concentrations in the world's oceans as a means of locating plankton and the schools of fish that feed on them. This information would be useful to commercial fisheries as well as to the marine science community.

The OCE acquired 78 minutes of cloud-free data, nearly twice the minimum mission requirement. It is anticipated that some of the ocean color data will be degraded because of the low relative Sun angle. However, excellent data are believed to have been acquired over the Mediterranean Sea, where concurrent ground data are also available for comparison.

The **Night/Day Optical Survey of Lightning** (NOSL) experiment consisted of a crew-operated, handheld instrument which took motion pictures and photocell readings of lightning and thunderstorms. The techniques involved in gathering and analyzing such data may be useful in the identifica-

tion of severe weather situations from meteorological satellites.

The data from the NOSL experiment were generally of low quality.

Reduction of the data acquired by the various sensors making up the OSTA-1 package is in progress, and image products are expected to be available sometime this spring from the National Space Science Data Center located at the Goddard Space Flight Center in Greenbelt, Md.

THE RUSSIAN EARTH RESOURCES SATELLITE

[The following article was adapted from a TASS report in PRAVDA, June 19, 1980.]

In June 1980, the U.S.S.R. launched a "Meteor" satellite equipped to observe the natural resources and meteorology of the Earth. The vehicle is part of an experiment to develop and optimize a methodology for an operational study of the Earth's surface based on multispectral information.

Three basic sensor packages are carried by Meteor. The first, the BIK-E sensor complex, comprises three subsystems: (1) an MSU-SK medium-resolution multispectral sensor with a conical optical-mechanical image scanner; (2) an MSU-E high-resolution multispectral solid-state scanner; and (3) a telemetry system.

A second sensor package is an experimental high-resolution multispectral system known as "Fragment." It consists of an optical-mechanical scanning unit, an information encoding and processing system, and telemetry system.

The third part of Meteor's sensor payload is the RTVK operational radio and television complex, which consists of: (1) a duplicate system of multispectral optical-mechanical scanning units with low (MSU-M) and medium (MSU-S) resolution capabilities; (2) onboard tape recorders; and (3) two telemetry systems operating in the meter and decimeter bands, both of which are standard equipment on satellites of the Meteor series.

Characteristics of these three sensor packages are given in the table accompanying this article. Some of the orbit characteristics of the spacecraft include:

- Altitude at apogee: 678 km
- Altitude at perigee: 589 km
- Orbit inclination: 98°
- Orbital period: 97.8 minutes.

Information from the BIK-E complex passes over a digital radio link to a receiving point in Obninsk. Primary data processing is performed at the State Scientific Research Center for the Study of Natural Resources. Information from the "Fragment" complex is transmitted over a digital radio link to a receiving point at the Moscow Institute of Power Engineering's Experimental Design Office, where it is recorded. Further processing of the data and generation of images on film are carried out with the help of specialized computer facilities at the U.S.S.R. Academy of Sciences' Institute of Space Research as well as the Center for the Study of Natural Resources. Information from the RTVK complex enters another network of receiving points.

The creation of the "Fragment" sensor was assisted by specialists from Karl Zeiss Jena in the Federal Republic of Germany, who developed and manufactured a reflecting telescope with a focal length of 1,000 mm and a diameter of 240 mm.

In addition to the goal of developing an operational method for the study of Earth Resources, the experiment of which Meteor is a part has the following objectives:

- Development of new equipment for obtaining multispectral video information in the visible and near-infrared bands of the spectrum.
- Development of systems and methods for the digital transmission of multispectral video information.
- Investigation and optimization of methods for both machine processing and visual interpretation of multispectral video information.
- Utilization, in a production mode, of multispectral video data in the solution of practical problems of Earth research from space.
- Development of recommendations for the construction of onboard and terrestrial sensing equipment, the organization of surveys, the collection of data, and the development of processing technology for use in prospective systems for studying the Earth from space on an operational basis.

BASIC PARAMETERS OF THE METEOR SATELLITE'S SENSOR COMPLEMENT

Parameter	Instrument Complex				
	BIK-E		"Fragment"	RTVK	
	MSU-E	MSU-SK		MSU-S	MSU-M
Field of view (km) for flight altitude of 650 km	30	600	85	1,400	2,000
Size of projection of field diaphragm (of a pixel) on the Earth's surface at nadir (m)	30	170	80	240	1,000
Spectral bands (μm)	0.5-0.7 0.7-0.8 0.8-1.0	0.5-0.6 0.6-0.7 0.7-0.8 0.8-1.0	0.4-0.8 0.5-0.6 0.6-0.7 0.7-0.8 0.7-1.1 1.2-1.3 1.5-1.8 2.1-2.4	0.5-0.7 0.7-1.0	0.5-0.6 0.6-0.7 0.7-0.8 0.8-1.0

DATA SALES REACH RECORD HIGH IN FY 1981

EDC's satellite and aircraft data sales for FY 1981 totaled $4,368,000. This figure is about 20 percent more than sales for FY 1980. Deliveries were rather evenly spread over all four quarters.

Landsat data accounted for 57 percent of the net shipped sales, aircraft data accounted for 33 percent, and miscellaneous data products accounted for about 10 percent. Sales of Landsat images increased 4 percent over the previous year's sales, while aircraft data sales increased 55 percent.

Non-U.S., industrial, and Federal agencies were the biggest users of Landsat imagery, with oil/gas and mineral exploration users being the most active group of consumers. Non-U.S. users accounted for 34 percent, industrial users for 27 percent, and Federal agencies for 20 percent of all dollar sales.

The increase in aircraft data sales was primarily due to a high level of interest in the National High-Altitude Photography (NHAP) Program and in photography acquired by the Bureau of Land Management. NHAP is a consortium of 13 U.S. Federal agencies which is collecting black-and-white and color-infrared photographic data over the 48 States during a 5-year period. The demand for these data is growing rapidly and is expected to increase as more coverage becomes available. User demand for older aircraft data is also growing and these continue to be valuable archive asset.

EDC received about 45,000 inquiries concerning satellite and aircraft data in FY 81. These inquiries generated approximately 25,000 orders. The average order turnaround time for the year was under 2 weeks for all orders.

Remotely sensed data analysis methods are undergoing rapid advancement in both the photographic and digital technique areas. The data needs of resource managers, coupled with new analysis developments, should result in a continued strong demand for the types of Earth resources data that are available from EDC.

FY '81 EROS DATA CENTER DATA DELIVERIES $4,367,785 *

LANDSAT IMAGERY & CCT'S 133,126 Items $2,495,268			AIRCRAFT IMAGERY 259,824 Frames $1,429,994	
% By Items	% By Dollars	Customer Category	% By Items	% By Dollars
22%	19%	Federal Government	48%	41%
3%	4%	State/Local Government	3%	4%
9%	8%	Academia	8%	8%
22%	31%	Industrial	30%	34%
7%	5%	Individual	9%	12%
37%	33%	Non-U.S.	2%	1%

*Includes $442,523 in miscellaneous deliveries

LANDSAT D SCHEDULE

The launch of Landsat D is expected to take place early in the third quarter of 1982 (calendar year). All activities leading to the launch are on or ahead of schedule. All flight segment hardware has been integrated, and the acceptance test cycle has been initiated. Ground segment hardware and software development are on schedule for an operational readiness test to be initiated in May 1982.

The second spacecraft in the series, Landsat D', will be available 12-15 months later and will be launched when Landsat D fails. Spacecraft lifetimes are projected to be 3 years.

Current plans call for the National Oceanic and Atmospheric Administration (NOAA) to become the operator and manager of the operational part of the Landsat D program early in 1983. NOAA will assume responsibility at that time for preprocessing of Landsat D MSS data and for services related to both archived and real-time Landsat data.

NOAA's recently established Landsat operations activity group is engaged in projects leading to the 1983 transfer of system management to NOAA. The group is working with NASA on implementation tasks.

LANDSAT 2 AND 3 STATUS REPORT

During a 9-week period starting late last August, a major adjustment was made to the **Landsat 2** orbit. This was the first major adjustment in 3 years. It should allow for continued operations through 1983.

In conjunction with the start of preliminary acquisition testing by Thailand in November, Landsat 2's power limitations were investigated further. All ground station operators are being advised as necessary regarding the acquisition capability of this platform.

Landsat 3 return beam vidicon (RBV) operations were constrained to a real-time mode when the onboard tape recorder being used for RBV data failed on October 15, 1981. Because of the problems involved in using the one remaining recorder in multiple modes, its use is now restricted primarily to MSS data acquisition. Small quantities of

recorded RBV data may still be acquired, but only on special request.

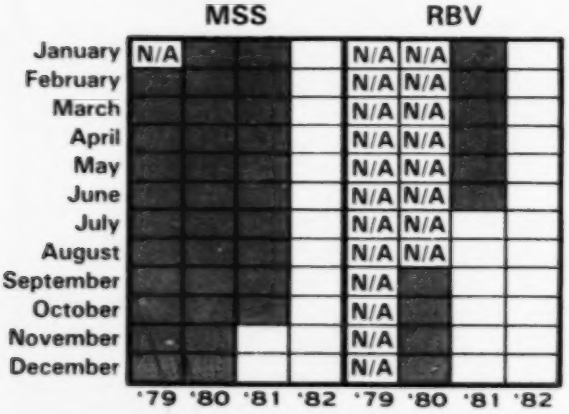
Current plans are to operate both Landsats through March 1983, after which their use may be gradually phased out as Landsat D assumes the role of primary user spacecraft.

Indonesia has signed a Memorandum of Understanding with NASA, making it the most recent member of the group of countries operating Landsat ground stations worldwide.

STATUS OF GSFC DIGITAL PROCESSING

Because of various ground system problems that occurred after the commencement of digital operations between GSFC and EDC in 1979, the flow of Landsat data to EDC suffered frequent interruptions even though acquisitions by the satellites were continuing. This situation resulted in a significant backlog of data waiting to be processed at GSFC, and it was not until recently that any substantial progress could be made toward eliminating it.

In the past year, significant reductions in the Landsat digital processing backlog have been accomplished which have allowed certain monthly increments of data to be "closed out." These are shown in the chart below. Where a month is closed out, it means that all processable Landsat MSS and RBV scenes acquired during that month have been processed and sent to EDC. The chart is current as of February 1, 1982. It should be noted that digital processing of RBV data did not start until September 1980.



RBV WORLDWIDE COVERAGE PROJECT CONSTRAINED

A project to systematically acquire Landsat 3 return beam vidicon (RBV) imagery of all the land masses of the world may soon be constrained after little more than a year in operation. The reason is that Landsat 3 RBV operations are restricted primarily to real time mode since failure of one of the onboard tape recorders October 15, 1981. The remaining recorder is being used mainly for MSS data at this time.

The RBV Worldwide Coverage project began as an effort to acquire at least one good scene for every path/row location falling over a land mass. Scenes with 30 percent cloud cover or less, and which met overall quality standards, were to be selected to create a permanent digital archive of one-time RBV coverage.

Unfortunately, only 17 percent of the total number of scenes possible under this project had been acquired when the tape recorder failed last October. This figure equates to about 1,800 scenes out of a possible 10,554.

North America and Africa have the most coverage at this point in the project, with about 35 percent of the total number of acquisitions planned for these continents having actually been obtained. Other major land masses, such as Eurasia and South America, have received significantly less coverage—around 10 percent.

All scenes that have been acquired under the RBV Worldwide Coverage project are available in either photographic or digital form from EDC. Contact the User Services Section at EDC for specific information on which path/row points are available.

6250-BPI CCT'S AVAILABLE

Computer-compatible tapes (CCT's) of Landsat imagery are now available at a packing density of 6250 bits per inch (bpi). The 9-track, 6250 bpi tapes cost the same as CCT's reproduced at other densities (1600 bpi and 800 bpi, for example). The only difference is that more data can be packed on the new tapes, reducing the storage requirements of those who maintain extensive CCT libraries.

In the past, CCT's have generally been sold as tape sets. A customer ordering all four bands of an MSS scene, for instance, received two 1600 bpi tapes or three 800 bpi tapes depending on the density requested. The new 6250 bpi CCT's, however, can contain the same amount of data on a single tape.

MSS tape sets at the lower densities will still be available, and RBV data will still be sold on a tape per subscene basis.

Customers should ensure that their equipment can handle 6250 bpi data before ordering CCT's at this density. Tape drives having such a capability are widely available from commercial sources. Any questions concerning the production of 6250 bpi CCT data at EDC should be directed to the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone (605) 594-6151.

STANDING REQUEST SYSTEM CHANGED

EDC recently eliminated the "Report Only" option from its Standing Request System. Under this option, customers had been able to automatically receive computer printouts describing new Landsat acquisitions over their areas of interest.

The reason for dropping the "Report Only" option was that customer interest had fallen in re-

cent years. Too few requests were being received to justify the expense of maintaining the service.

A second option in the Standing Request System, the "Auto Order" option, is being continued. This option allows the customer to maintain a standing order for any specific data products meeting his criteria. As soon as the source data are received at EDC, the order is filled and shipped automatically.

To place an "Auto Order" standing request, users should contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6151.

NEW MEDIA FOR DIGITAL PRODUCTS

The EROS Data Center plans to start offering full Landsat scenes in tape cartridge format soon. The price of each cassette will be $300, the same as currently charged for CCT's. Production capacity will be limited initially, but plans have been made to expand production quickly if user demand indicates a need.

Also, 8-inch floppy disks containing Landsat data will be offered. These will be single-sided, single-density, CP/M compatible disks containing subsets of Landsat scenes which will be selectable by area.

The techniques used to format Landsat data on tape cartridges and floppy disk media were developed in conjunction with the designing of the EDC Remote Image Processing System (RIPS). This is a microprocessor-based image analysis system whose primary advantages are low cost and portability. Its use of advanced data storage techniques had obvious implications for new product development.

Readers may direct any questions to the Computer Services Branch, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6555.

LANDSAT HISTORICAL MSS DIGITAL DATA BANK PROJECT

Since the launch of Landsat 1 in July 1972, the three Landsat satellites have collected more than 1 million scenes of MSS data throughout the world. Of this total, more than 350,000 scenes were recorded on wideband video tape at one of the three NASA receiving stations.

Until 1979 the wideband video tape data were routinely converted to analog images at the Goddard Space Flight Center by electron-beam recorder (EBR). Very few scenes were converted to digital form in response to specific customer orders. Therefore, the vast majority of Landsat data collected from 1972 until 1979 existed only as wideband video tape recordings or as EBR-generated 70-mm film. Because wideband video tape data can deteriorate with age, it became desirable to upgrade this data archive by creating a permanent archive of digital data. The wideband video tapes could then be destroyed or reused for other purposes. The EROS Data Center started a project to select scenes of highest historical value while minimizing the number of scenes that would have to be reprocessed through the ground data handling system.

It was recognized that certain areas of the world are subject to more seasonal variations than other areas. It was felt that for those areas where there are four distinct seasons of the year, it would be desirable to archive a sample of data taken during each of the four seasons in each year of satellite operations. For areas where seasonal variation was minimal, only one scene from each year of operation would be required.

A review of the current status of this project shows that EDC has completed scene selection for the years 1972 through 1976 (approximately 30,000 scenes) and that GSFC has converted approximately 4,000 of these scenes to digital form. These have been added to the 12,000 scenes (approx.) that were already in the EDC digital archive as a result of customer-generated requests for pre-1979 data in past years.

CCT USERS PLEASE NOTE: The conversion of selected 1972 data from wideband video tape to CCT's will be completed within the next few months. Starting on August 1, 1982, all 1972-acquired wideband video tapes will be retired from the GSFC archive. No further conversion of those data to CCT's will be possible after that date, although the film archive will remain intact. Therefore, if you need to order CCT's of any of these 1972 data, your order must be placed with EDC before July 1, 1982.

A brief review of the scene selection procedure used in the project is provided below for the benefit of users who may be ordering from the MSS Data Bank.

Selection Plan Design

The world climate map by Strahler and Strahler[1] partitions the global landscape into 14 major climate categories, a level of detail deemed appropriate for the purposes of this project. The climate categories were considered along with information about their associated vegetation types in order to estimate the number of Landsat scenes which would be required to capture significant variations in landscape appearance due to seasonality.

The boundaries of the climatic categories were then transferred from the original small-scale world climate map to their respective Worldwide Reference System (WRS) Landsat Coverage Index Sheets. Notations of local seasonality (expressed as astronomic seasons related to local Sun position) were made in the margin of each index sheet to help locate the correct selection data, or dates, as specified in the guidelines.

After the relevant data had been added to the Landsat Coverage Index Sheets, general summaries of the number of scenes required for each sheet were prepared.

Although the phenology related criteria provided a specific target date for scene selection, a candidate scene also had to meet strict quality standards in order to be included in the Data Bank. The maximum acceptable cloud cover, for example,

[1]Strahler, A.N., and H.H. Strahler, 1978. Modern Physical Geography. John Wiley and Sons, New York.

was established at 30 percent. In addition, the digital tape containing the scene could not have missing bands or other such defects which could detract from its usefulness as a historical record.

Strategy for Implementation

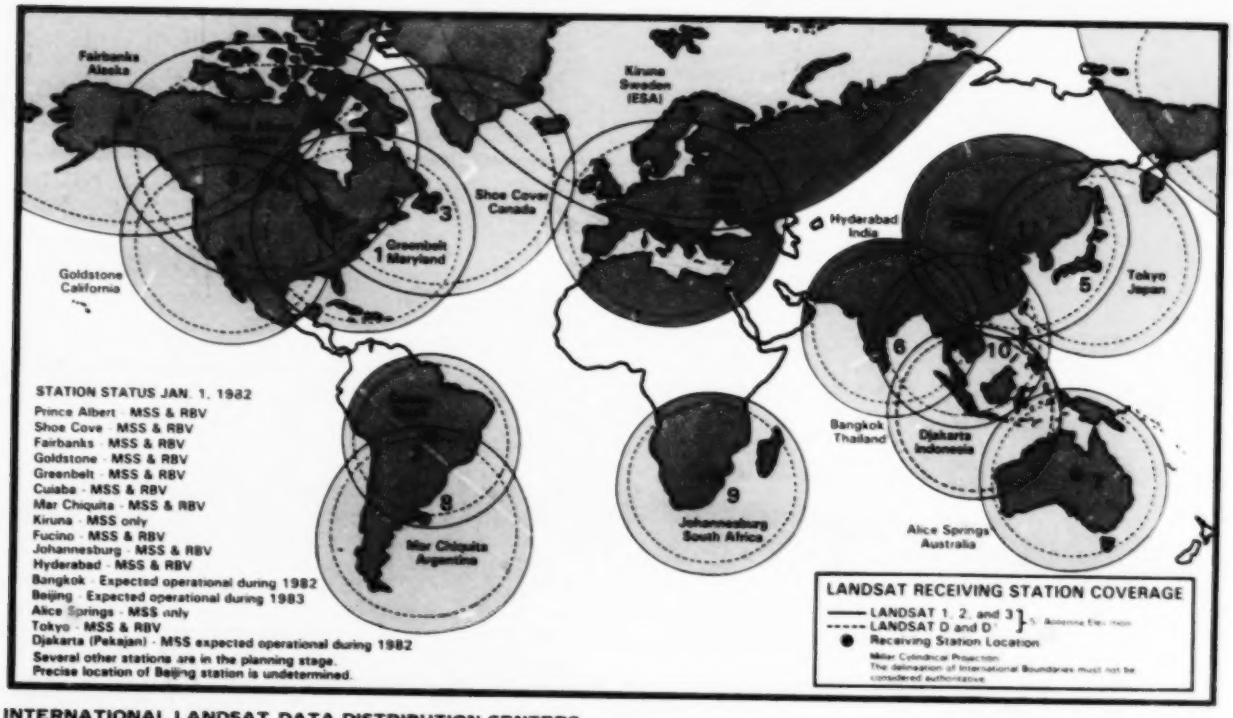
Use of the index sheets with climatic zone boundary and seasonality requirements allowed a specific date (or dates) to be suggested for each Landsat MSS scene center point (path/row designation) worldwide. Ideally, a scene would be available which would not only fall on the required date, but which would satisfy the cloud cover and technical quality requirements as well. However, it was expected that exact matches would be rare. Therefore, in practical use, the selection dates were considered as target dates only. Each target date thus represented the center of a selection "window" from which scenes were to be chosen. Relatively minor deviations from the target dates did not negate the logic and rationale of the selection criteria.

Additional information regarding this project can be obtained by contacting the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone (605) 594-6151.

ERRATA

In the September 1981 issue of this newsletter (no. 20), a map depicting the real-time coverage areas of Landsat ground stations worldwide appeared on page 3. This map, as printed, carried no legend defining the significance of the broken and solid line patterns used, and it bore no annotation describing the current reception capabilities of the stations shown (MSS, RBV, or both).

A second version of the map in this issue (below) contains that information.


Fairbanks Alaska
Kiruna Sweden (ESA)
Shoe Cove Canada
Greenbelt Maryland
Goldstone California
Hyderabad India
Tokyo Japan
Bangkok Thailand
Djakarta Indonesia
Alice Springs Australia
Mar Chiquita Argentina
Johannesburg South Africa
STATION STATUS JAN. 1, 1982
Prince Albert - MSS & RBV
Shoe Cove - MSS & RBV
Fairbanks - MSS & RBV
Goldstone - MSS & RBV
Greenbelt - MSS & RBV
Cuiaba - MSS & RBV
Mar Chiquita - MSS & RBV
Kiruna - MSS only
Fucino - MSS & RBV
Johannesburg - MSS & RBV
Hyderabad - MSS & RBV
Bangkok - Expected operational during 1982
Beijing - Expected operational during 1983
Alice Springs - MSS only
Tokyo - MSS & RBV
Djakarta (Pekajan) - MSS expected operational during 1982
Several other stations are in the planning stage.
Precise location of Beijing station is undetermined.
LANDSAT RECEIVING STATION COVERAGE
LANDSAT 1, 2, and 3
LANDSAT D and D'
Receiving Station Location
Miller Cylindrical Projection
The delineation of international boundaries must not be considered authoritative.

INTERNATIONAL LANDSAT DATA DISTRIBUTION CENTERS

1 User Services Section
EROS Data Center
U.S. Geological Survey
Sioux Falls, South Dakota 57198

2 Instituto de Pesquisas Espacias (INPE)
Departamento de Producao de Imagens
ATUS-Banco de Imagens Terrestres
Rodovia Presidente Dutra, Km 210
Cachoeira Paulista-CEP 12.630
Sao Paulo, Brazil

3 Canadian Centre for Remote Sensing (CCRS)
User Assistance and Marketing Unit
717 Belfast Road
Ottawa, Ontario K1A 0Y7
Canada

4 European Space Agency (ESA)
Earthnet User Services
Via Galileo Galilei
000 44 Frascati, Italy

5 Remote Sensing Technology Center (RESTEC)
7-15-17 Roppongi, Minato-Ku
Tokyo 106, Japan

6 Director, National Remote Sensing Agency
No. 4 Sardar Patel Road
Hyderabad-500 003
Andhra Pradesh, India

7 Australian Landsat Station
14-16 Oatley Court
P.O. Box 28
Belconnen, A.C.T. 2616
Australia

8 Comision Nacional de Investigaciones Espaciales (CNIE)
Centro de Procesamiento
Dorrego 4010
(1425) Buenos Aires, Argentina

9 Director, National Institute for Telecommunications Research
ATTN: Satellite Remote Sensing Centre
P.O. Box 3718
Johannesburg 2000
Republic of South Africa

10 Remote Sensing Division
National Research Council
Bangkok 9
Thailand

11 Academia Sinica
Landsat Ground Station
Beijing
People's Republic of China

PUBLICATION ON SPACE OBLIQUE MERCATOR AVAILABLE

U.S. Geological Survey Bulletin 1518, **Space Oblique Mercator Projection–Mathematical Development,** by John P. Snyder, was recently published. It contains refined and improved equations that can be applied to Landsat and other near-polar orbiting satellite parameters to describe a continuous true-to-scale groundtrack. The equations will contribute to the automated production of image base maps. The 108-page book is available through the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Refer to Stock No. 024-001-03441-7 when ordering. The price is $4.75.

REMOTE SENSING TRAINING FILMS

Two remote sensing training films have been released by the American Society of Photogrammetry (ASP). Entitled "Vegetation Mapping: The Use of Remotely Sensed Data," and "Mineral Exploration: The Use of Remotely Sensed Data," the films use case examples to illustrate the use of satellite imagery, aerial photography, computer-assisted analysis, and ground sampling methods in solving resource problems.

Each 28-minute, color and sound film can be purchased in 16-mm film format for $250, or as ½-inch (Beta or VHS) or ¾-inch video cassettes for $100. Contact the ASP Foundation, 105 N. Virginia Ave., Falls Church, VA 22046, telephone: (703) 534-6617, for further information.

The EROS Data Center has a limited number of copies that are available on a short-term loan basis. For information on these copies, contact the Technical Communications Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6171.

REMOTE SENSING PROGRAM IN INDIA

The Indian Photo-Interpretation Institute (IPI), a part of India's National Remote Sensing Agency (NRSA), each year offers a variety of courses within its "Training Programme in Aerial Photo-Interpretation and Remote Sensing Techniques." IPI was established in 1966 at Dehra Dun, India, in collaboration with The Netherlands' International Institute for Aerial Survey and Earth Sciences. Courses range in length from 4 days to 12 months and emphasize the use of photointerpretation and remote sensing techniques for surveying, mapping, and assessing resources in many disciplines, including forestry, geology, hydrogeology, geomorphology, and soils. Introductory photogrammetry, photointerpretation, and remote sensing courses are also offered. For information about this training, contact The Dean, Indian Photo-Interpretation Institute (NRSA), 4 Kalidas Road, Post Box No. 135, Dehra Dun-248001, India.

SYMPOSIA

A **Symposium on Remote Sensing and Mineral Exploration** will be held as part of the 24th COSPAR (Committee on Space Research) Conference this May, 1982, in Ottawa, Canada. COSPAR is an organization within the International Council of Scientific Unions. The symposium's organizers, W. D. Carter and L. C. Rowan, both of the U.S. Geological Survey, have solicited papers documenting case histories on the use of Landsat data in mineral and energy resource exploration. The 11 sessions planned will run from May 17 to 22. Details on the COSPAR Conference may be obtained from the Executive Member, LOC XXIV COSPAR, Conference Secretariat, National Research Council, Ottawa, Ontario K1A 0R6, Canada.

The **16th International Symposium on Remote Sensing of Environment** will be held in Buenos Aires, Argentina, June 2-9, 1982. Organized and conducted jointly by the Environmental Research Institute of Michigan (ERIM) and the Argentine National Commission on Space Research (CNIE), this symposium will stress the application of remote sensing technology to problems in developing countries, emphasizing topics of regional importance. Simultaneous interpretations in English or Spanish, as appropriate, will be provided at the formal paper sessions. Registration information and other details about the symposium are available from Dorothy M. Humphrey, Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, MI 48107, telephone: (313) 994-1220.

The **8th International Symposium on Machine Processing of Remotely Sensed Data** will be held July 7-9, 1982, at Purdue University in West Lafayette, Ind. Crop inventory will be emphasized, and topics will include research results in digital modeling of remotely sensed scenes, information extraction from digital remotely sensed and ancillary data, and utilization of digitally processed data related to Earth resources. A call for papers has been issued. For more information, contact D. B. Morrison, Symposium Coordinator, Purdue University/LARS, 1220 Potter Drive, West Lafayette, IN 47906, telephone: (317) 749-2052.

A symposium entitled **Advances in Instrumentation of Processing and Analysis of Photogrammetric and Remote Sensing Data** will take place August 30 to September 3, 1982, in Ottawa, Canada. It is sponsored by Commission II of the International Society of Photogrammetry and Remote Sensing. A call for papers has been issued. For further information, contact Z. Jaksic, President, Commission II (ISP/RS), Division of Physics, National Research Council of Canada, Bldg. M-36, Montreal Road, Ottawa, Ontario K1A 0R6, Canada, telephone: (613) 993-2074.

The **International Society for Photogrammetry and Remote Sensing** will host a symposium in Toulouse, France, September 13-17, 1982. The symposium will present the activities of the Society's Commission VII working groups relevant to two main subjects: (1) the methodologies for joint

operational use of photogrammetry and remotely sensed data and (2) the use of a new generation of operational satellites that should be available in the 1980's. An international exhibition will be held concurrently with the symposium. For further information, contact:

Groupement pour le Developement
de la Teledection Aerospatiale
18, avenue Edouard Belin
31055 Toulouse Cedex, FRANCE
Tel: (61) 53.11.12

The American Congress on Surveying and Mapping (ACSM) and the American Society of Photogrammetry (ASP) will hold their 1982 Fall Convention in Fort Lauderdale/Hollywood, Florida, September 19-23, 1982. In conjunction with this conference, a **National Symposium on the Profession in Private Practice** will be presented. Organized by the ASP Florida Region and the Florida Society of Professional Land Surveyors, this special symposium will focus on the business problems, legislative affairs, legal matters, and Governmental contracting practices that face the professional photogrammetrist and surveyor today. Further information on this symposium can be obtained from Janet D. Degner, Department of Civil Engineering, University of Florida, Gainesville, FA 32611, telephone: (904) 392-1436.

EDC TRAINING SCHEDULE

The EROS Data Center's Applications Branch will conduct or assist in presenting several training courses and workshops in the coming months.

April 26 - May 28 **International Remote Sensing Workshop: Applications in Geologic and Hydrologic Exploration and Planning** (Sioux Falls, S. Dak.) Open to non-U.S. scientists only. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092.

June 7-11 **Digital Land Cover Classification Techniques** (Sioux Falls, S. Dak.) Advanced. Contact: Chief, Training and Assistance, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

Aug. 30 - Oct. 1 **International Remote Sensing Workshop: Applications in Vegetation Assessment and Land Use Planning** (Sioux Falls, S. Dak.) Open to non-U.S. scientists only. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092.

LANDSAT PRODUCTION STATISTICS

	June '81		July '81		Aug '81		Sept '81		Oct '81		Nov '81		6 Month Total	
	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV
Landsat scenes acquired (satellite acquisitions)*	3,339	946	2,884	561	3,311	504	2,764	898	2,585	534	1,813	170	16,696	3,613
Landsat MSS scenes RBV subscenes received at EDC	3,420	2,678	4,611	2,640	3,519	2,672	4,036	1,132	3,486	2,403	3,620	1,081	22,692	12,606
Average time in days from EDC receipt to archive availability	7.2	5.2	13.5	13.8	19.8	21.9	20.6	18.1	9.3	35.4	32.6	13.9		
Average delivery time from receipt of order at EDC to shipment:														
Standard photographic products	15		15		12		13		17		20			
Standard digital products**	13		13		8		9		15		14			
Landsat photographic frames sold	11,594		11,958		10,187		7,654		16,678		7,991		66,062	
Landsat digital scenes sold	301		280		430		363		940		542		2,856	
TOTAL LANDSAT DOLLAR VOLUME	$205,060		$225,385		$219,857		$160,268		$374,922		$224,486		$1,409,978	

*Figures are revised periodically to reflect updated information received from NASA.

**Standard digital products average 3 days in production — balance of turnaround is for the 9-in. prints shipped with the tapes.

EDC HISTORICAL LANDSAT STATISTICS (FY 1973 - FY 1981)

	FY '73	FY '74	FY '75	FY '76	FY '77	FY '78	FY '79	FY '80	FY '81
Landsat 1 MSS Scenes Acq'd	46,354	11,764	55,284	14,109	12,288	4,964	51	0	0
Landsat 2 MSS Scenes Acq'd			10,962	53,704	25,282	44,715	12,886	8,325	20,457
Landsat 3 MSS Scenes Acq'd						12,350	22,452	18,032	13,237
TOTAL LANDSAT MSS SCENES ACQUIRED	46,354	11,764	66,246	67,813	37,568	62,029	35,389	26,357	33,694
Landsat 2 RBV Scenes Acq'd			575	479	949	64	24	11	46
Landsat 3 RBV Scenes Acq'd						3,221	4,234	16,684	15,112
TOTAL LANDSAT RBV SCENES ACQUIRED			575	479	949	3,285	4,258	16,695	15,158
Landsat Photographic Frames Sold	81,071	157,178	197,654	297,253	130,100	110,723	134,482	128,433	128,775
Landsat Digital Scenes Sold	10	228	729	3,299	1,887	2,853	2,982	4,139	4,351
Dollar Volume of Total Landsat Sales	$229,642	$564,994	$909,009	$2,093,664	$1,453,837	$1,976,068	$2,131,813	$2,388,567	$2,495,268
Customer Profile of Total Landsat Data (by $ value):									
Federal Government	27%	16%	21%	34%	26%	31%	23%	16%	19%
State Local Government	5%	2%	2%	1%	1%	1%	1%	3%	4%
Academic	13%	12%	16%	11%	10%	8%	11%	9%	8%
Industrial	30%	22%	24%	21%	28%	24%	24%	26%	31%
Individual	7%	13%	11%	8%	5%	4%	5%	4%	5%
Non U.S.	12%	23%	19%	25%	30%	32%	36%	42%	33%
Non Identified	6%	12%	7%	0%	0%	0%	0%	0%	0%

*Fiscal years 1973 1975 lasted from July to June. FY 1976 lasted from July 1975 to September 1976. FY 1977 1981 lasted from October to September

The Landsat Data Users NOTES is published bimonthly in order to present information of interest to the user community regarding Landsat products, systems, and related remote sensing developments. There is no subscription charge. Individuals and organizations wishing to receive the NOTES should contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, U.S.A., telephone (605)594-6151.

Comments, corrections, and other inquiries should be directed to:

Editor, Landsat NOTES
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198

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PUBLIC MEETINGS ON NOAA'S LANDSAT D DATA COLLECTION PLANS

Final plans are being formulated to implement an interim operational civil land remote sensing satellite system on January 31, 1983, under the management of the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce. This system will be based upon the Landsat D and Landsat D' spacecraft now being built by NASA. A new ground processing system under construction at the Goddard Space Flight Center in Greenbelt, Md., will preprocess the data from these satellites. Image and digital data products will be made available from the Earth Resources Observation Systems (EROS) Data Center (EDC), in Sioux Falls, S. Dak., under an arrangement between NOAA and the U.S. Geological Survey.

NOAA recently announced plans for new and improved Landsat data services, and, in addition, announced a series of price increases (about 2.5 times higher than current levels) which will go into effect on October 1, 1982. Administration policy calls for the shifting of responsibility for U.S. satellite land remote sensing activities to the private sector sometime in the 1980's.

NOAA has also announced that it would release its tentative plans regarding both special data acquisitions and routine Basic Data Set acquisitions by the multispectral scanner (MSS) instrument aboard Landsat D by April 1982. Before these plans are finalized, however, response and advice from the user community will be solicited.

Opportunities to comment first-hand on the proposed data collection approach will be offered through a series of public meetings which NOAA will host at several locations around the country. These meetings will begin in Washington, D.C., on April 20 and conclude on the West Coast in mid-June. Announcements in letters, trade journals, and professional society publications will follow.

NOAA officials will be at the following locations on the dates indicated:

April 20	Department of Commerce Auditorium 14th Street and Constitution Avenue, N.W. Washington, D.C.
April 30	William Marsh Rice University Department of Space Physics & Astronomy Sewall Hall, Room 301 Houston, TX
May 4	NASA/MSFC Michoud Assembly Facility (Auditorium) New Orleans, LA
June 3	National Bureau of Standards Auditorium 325 Broadway, Radio Building Boulder, CO
June 8	Presidio of San Francisco Presidio Post Theatre, Building 99 San Francisco, CA

Registration for each meeting will begin at 8:00 a.m. The meetings will start at 8:45 a.m. To ensure appropriate accommodations, please call NOAA's User Affairs Office to inform them of which meeting you will attend. The number is (301) 763-7822.

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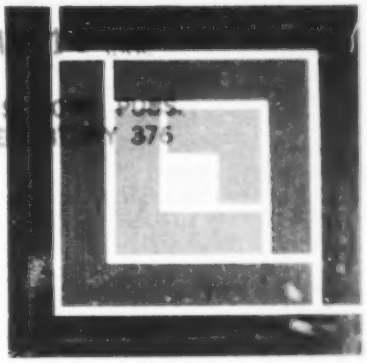


Landsat Data Users NOTES

ISSUE NO. 22
MARCH 1982

NASA

U.S. GEOLOGICAL SURVEY
EROS DATA CENTER
Sioux Falls, S. Dak. 57198

COLUMBIA RIVER TRIBUTARIES PROJECT

A project concerned with analysis of irrigation withdrawals was recently completed as the result of a joint effort by EROS Data Center scientists and the U.S. Army Corps of Engineers, Portland District. The purpose of the project was to evaluate the utility of both Landsat imagery and conventional aerial photography, when used with spatial analysis techniques, for determining the current extent of irrigation and the potential for future irrigation development in two basins within the Columbia River system.

The Umatilla Basin in the State of Oregon was the primary study area. This 6,500-km² (2,500-mi²) area includes extensive regions that were developed for center pivot irrigation in the 1970's. A second, much smaller, study area consisted of three sites (36-mi² townships) in the Yakima Basin in the State of Washington. The Yakima sites served as a control group for crop classification. The areas studied have been intensively irrigated, using flood or towline sprinkler methods, since the early 1900's.

The project was designed to determine:

1. The existing (1979) level of irrigation.
2. The annual rate of irrigation expansion.
3. The growth rate of center pivot irrigation.
4. The types of crops being irrigated.
5. The water and energy requirements for existing irrigated lands.
6. The prime areas for future irrigation development.

The project began with mapping of general land cover categories in the Umatilla Basin. Areas of center pivot irrigation, other irrigation, dryland agriculture, rangeland, forests, water bodies, wetlands, and urban centers were manually interpreted from Landsat false-color composite images. Scenes from 1973, 1975, 1977, and 1979 were used to identify and measure changes in land cover in recent years. Results were supplemented with precise 1979 irrigation acreage estimates obtained from aerial photographs.

The specific types of crops under irrigation were then estimated for both the Yakima and Umatilla Basins. The estimates were made by developing statistical data from Landsat computer-compatible tapes (CCT's) and correlating unique data groups (clusters) with field-collected crop-type information. From the small subsets of digital data thus classified, comprehensive classifications of large areas were computed. The result was a digital data base containing crop-type information for one Yakima Basin site and all of the Umatilla Basin. Additional field data and aerial photographs were needed to supplement the Landsat estimates because the classification accuracies were less than desirable (77-percent correct in the Umatilla Basin; 71-percent correct in the Yakima site). The factors contributing to these low accuracies varied. In the Yakima Basin, small fields and great diversity in both crop type and irrigation method made classification difficult. In the Umatilla Basin, which is a much more homogeneous agricultural environment, differences in individual crop growth stages were factors affecting classification accuracy.

The water requirements for irrigated crops were determined next. The Landsat crop acreage estimates were combined with historic crop water requirement statistics developed by the Department of Agriculture to establish the number of acre-feet of water required for irrigation in both basins during 1979. Regional water requirement patterns were also established.

An analysis of energy requirements followed. This involved calculating the number of kilowatt-hours per acre that were used in 1979 to irrigate the Umatilla Basin. Digital topographic data and pumping locations were used to derive the spatial variables needed for the energy equation. Total diversion of water based on the previous acreage estimates, pumping plant efficiency, and other factors were taken from known data. Approximately 292 million kilowatt-hours of energy were estimated to have been used for the 1979 irrigation season in the Umatilla Basin.

At this point, the future irrigation potential in the Umatilla Basin was evaluated using a multivariable compositing procedure. Digital data describing land cover, land ownership, soil irrigability, percent slope, and potential energy requirements were registered to a common map base and overlayed. A composite map depicting the combined impact of both physical and economic factors on irrigation development potential in the northern 4,450 km² in the Umatilla Basin was subsequently produced. From this map, areas having the greatest likelihood for future irrigation development could be identified.

A potential problem with the spatial data model developed in this project is that any such model can only be as valid as the assumptions and data used to create it. However, a distinct advantage of such a model is that once the data are in digital form and can be manipulated using a computer, different weightings or scenarios can be proposed and rapidly displayed and evaluated for planning purposes.

This project therefore offered an ideal test-of-concept for Landsat-based spatial data analysis systems. In arriving at answers to the problems presented, the acquisition and synthesis of a considerable amount of geographically referenced data was required. These data were used to develop a digital data base containing variables representing irrigation-related physical, administrative, and economic conditions. Through the computer-assisted analysis and modeling that was possible as a result, the tasks of resource planning and management by Corps of Engineers personnel were aided.

Furthermore, the data will be available for additional analyses as conditions affecting irrigation in the project study areas continue to change. Additional information on this work can be obtained from the Information Officer, Applications Branch, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

THE NATIONAL CARTOGRAPHIC INFORMATION CENTER

Established by the U.S. Geological Survey in 1974, the National Cartographic Information Center (NCIC), acquires information on cartographic, geographic, and remotely sensed data of the United States, and disseminates this information to users. EDC works closely with NCIC, sharing both program and computer resources.

Common types of cartographic data are maps and charts, digital mapping data, aerial photographs, and geodetic control data. Increasingly, the innumerable applications relating this information to the Earth and its resources are being used to broaden the scope of Landsat investigations.

Other prominent categories of cartographic information being integrated into current investigations include hydrologic reports, census statistics, survey descriptions, governmental publications, and magnetic data. NCIC does not physically obtain all of these cartographic data itself, but it does accumulate and organize comprehensive descriptive information identifying where such data are held and how users may obtain them. That information is made available, on request, through NCIC's 7 offices and 31 State and Federal affiliate offices, where user assistance is provided.

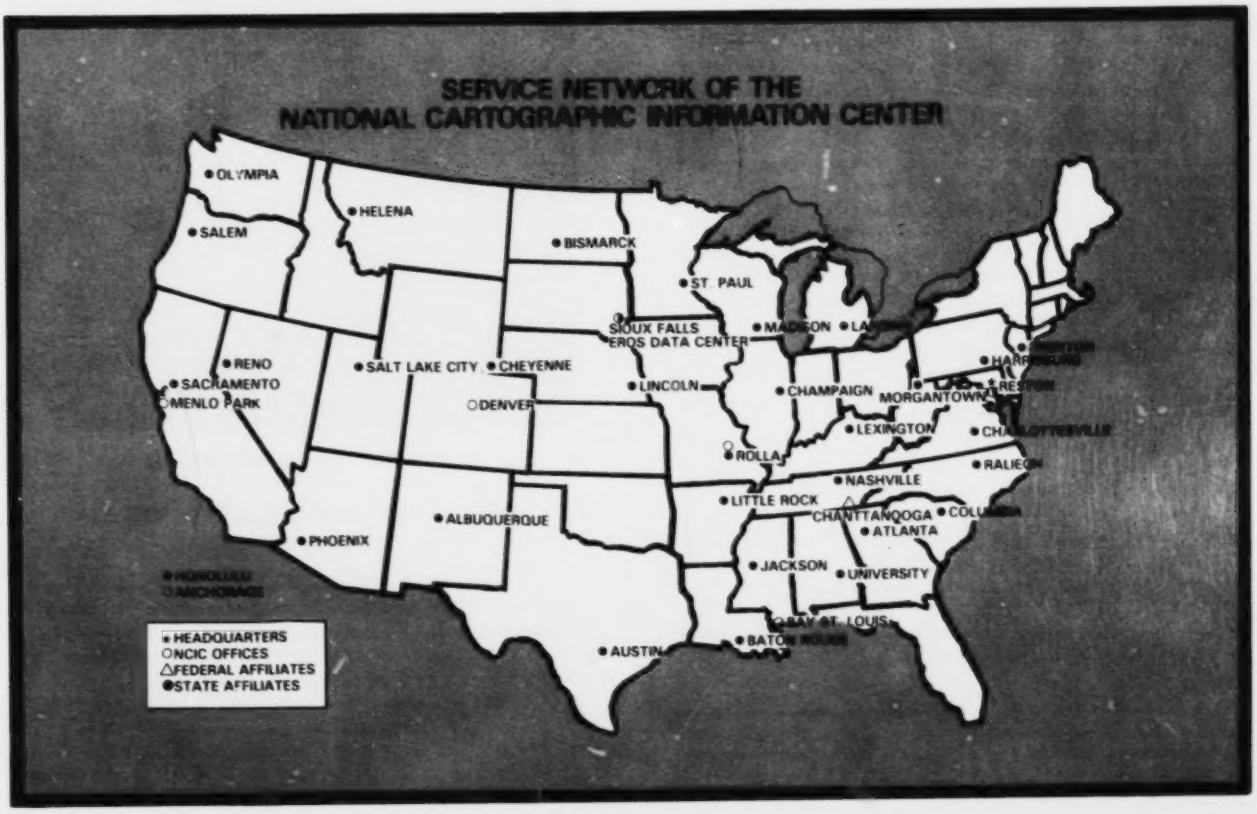
As a user service organization, NCIC uses comprehensive information systems, ranging from micrographic reference aids to computerized data bases, to provide timely answers to inquiries. For example, 17 NCIC and State affiliate offices are tied into the computerized data base at EDC to facilitate on-line access to information on the nearly 6 million frames of aircraft and satellite imagery archived at EDC.

NCIC and EDC have created a microfiche reference system, called Accession Aids, which is organized so that the aircraft and satellite data archived at EDC may be geographically researched without computer access to the data base. Records of additional millions of frames of existing and planned aerial photographs are organized in NCIC's Aerial Photography Summary Record System (APSRS).

A micrographics-based Map and Chart Information System (MCIS) contains information on domestic maps and charts, both current and historical. NCIC offices use this data base to respond to customer requests for information on map availability.

With the aid of these systems and others, NCIC is a valuable source of information to those who work with remotely sensed data. Readers interested in obtaining more information about the services and data available through NCIC are encouraged to contact:

National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, VA 22092
telephone: (703) 860-6045
FTS: 928-6045



RBV DODGED PRINTS

Photographically enhanced return beam vidicon (RBV) images are being produced by EDC as one means of compensating for the vidicon-related "shading" problem.

Shading is an artifact in Landsat 3 RBV data which has been of concern since these data started being processed in a production mode in September 1980. Essentially, it is a manifestation of differences in response to scene brightness across each camera lens (see issue no. 16). The effect in photographic prints produced from these data is an undesirable distribution of densities over the dynamic range of the film. Dark and light areas are accentuated, and ground details at either end of the range become difficult to discern.

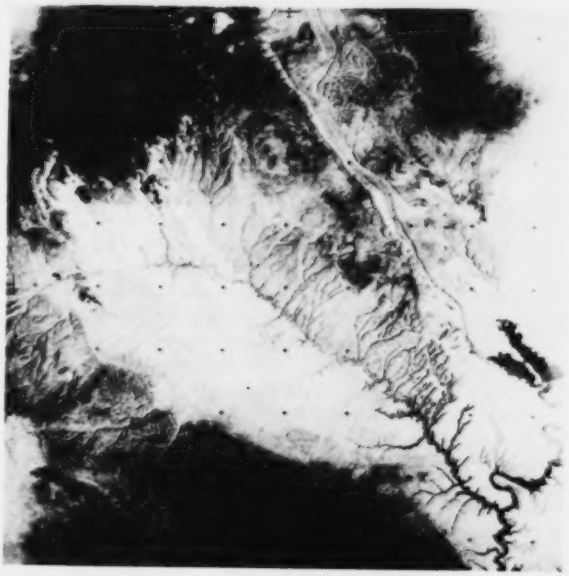
The most successful attempts at compensating for this effect have employed digital processing. One technique involves averaging several scenes of uniform contrast and then digitally subtracting the result from a shaded image, pixel by pixel. Such a bias correction was discussed in these columns last September (issue no. 20).

A simpler, more cost effective way of averaging high and low densities in a photographic image is to "dodge" the image. Dodging is a photographic technique whereby the light source used during the printing process is modulated according to the density of the master image. Darks areas on a photographic negative, for example, can be given more light to bring out low densities on the positive print. Conversely, areas of high density can be toned down. Specialized dodging printers can do this electronically, sensing changes in the density of the negative and varying the exposure allowed over corresponding areas in the positive. A very high-contrast scene can thus be adjusted photographically to be of more uniform contrast.

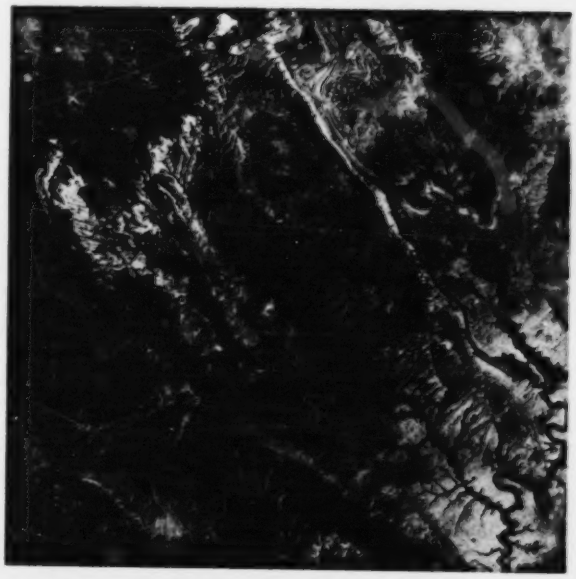
As long as the shading is non-linear, dodging does result in a visible improvement in the appearance of the image. This has been found to aid interpretation for some applications because details formerly obscured at high and low densities often become easier to discern when reproduced at medium densities.

EDC is now dodging all contact-size RBV photographic products as a standard procedure. Customers may still obtain undodged reproductions, but a special instruction to this effect must be included on the order form. Enlarged RBV products are not being dodged unless specifically requested by the customer; with orders for dodged enlargements, a $12 surcharge will be added to the product price to cover the cost of the required internegative.

These services apply only to RBV data that have been processed in digital mode since September 1980. Please contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6151, if you have any questions.



RBV Image Before Dodging



RBV Image After Dodging

STATUS: LANDSAT 2 AND 3

On February 25, 1982, **Landsat 2** was removed from operational service. Following a series of yaw control problems that began in mid-January, the yaw-axis flywheel stopped functioning. Efforts by NASA to restart the wheel have been unsuccessful so far, and the prognosis is not good.

Aside from the obvious effect of degraded attitude control on any data obtained, spacecraft motion in the yaw-axis results in insufficient solar array power, causing power management problems aboard the satellite. Low power conditions were responsible for frequent breaks in service during February, and command and communications were impossible to establish at times.

The same flywheel stopped once before, in November 1979, but it restarted in June 1980. Landsat 2 provided no data during that 7-month period, but has been the prime data collection platform ever since. It has far exceeded its expected design life, having provided almost continuous service since its launch in January 1975.

Landsat 3 is also having serious problems. The end-of-scan pulse on MSS light source "B" began deteriorating last fall, and by December a switch to light source "A" had to be made. This has worked so far, but eventual degradation of the source "A" pulse must be expected. Neither source "A" nor source "B" has provided a start-of-scan pulse for quite some time; this function is being handled by a pseudopulse generated in the MSS multiplexer.

Along with the end-of-scan pulse problem, recent evaluation of Landsat 3 data has shown that a jitter problem in the MSS mirror system has been worsening in the last few months. Variations in mirror position relative to the pseudopulse generated by the MSS multiplexer are increasing. In the potential absence of an end-of-scan pulse, these variations will be too great to permit accurate data processing or subsequent registration of images. Variations of three to seven pixels have already been observed in uncorrected data.

The problem is compounded by the fact that the multiplexer onboard Landsat 3 has failed in the past (later recovering inexplicably) and could fail again at any time.

The chances of resolving these problems are considered minimal. At present, the duty cycle of the Landsat 3 spacecraft is being limited as much as possible in an effort to prolong its useful life, at least until Landsat D is operational.

BAND NUMBERING TO CHANGE WITH LANDSAT D

Among the many changes to take effect after the launch of Landsat D will be the numbering system used to designate the different bands of multispectral scanner (MSS) data. Bands 4, 5, 6, and 7, which have been associated with the MSS on Landsats in the past, will be known as bands 1, 2, 3, and 4, respectively, on Landsat D.

The Landsat D MSS will be similar to the MSS instruments that have been flown on previous Landsats. It will sense data in the same four spectral bands, achieving similar radiometric sensitivity and ground resolution.[1] Only the band numbering will change.

The revised MSS numbering scheme is given in the chart below. Also shown is the numbering system that will be used to designate the thematic mapper (TM) bands. Users should note that these designations apply to Landsat D data only. MSS data from Landsats 1, 2, and 3 will be identified by the same band numbers they have always had (4, 5, 6, and 7) and should be ordered and otherwise designated accordingly.

LANDSAT D SPECTRAL BAND DESIGNATION

Band No.	Multispectral Scanner (MSS)	Thematic Mapper (TM)
1	0.5-0.6 μm	0.45- 0.52 μm
2	0.6-0.7 μm	0.52- 0.60 μm
3	0.7-0.8 μm	0.63- 0.69 μm
4	0.8-1.1 μm	0.76- 0.90 μm
5		1.55- 1.75 μm
6		10.40-12.50 μm
7		2.08- 2.35 μm

LANDSAT D PRODUCT GENERATION GOALS

Full production and operational output of Landsat D MSS data are expected within 6 months after launch. At that time, the Landsat D Image Generation Facility (IGF) at the NASA Goddard Space Flight Center (GSFC) will be operated to produce up to 133 MSS scenes per day. These data will be formatted as partially processed archival high-density tapes (HDT-A's) from which other user products such as photographic images or computer-compatible tapes (CCT's) can be made. The planned turnaround time from receipt of raw data at GSFC to generation of HDT-A's is 48 hours. The HDT data will be transmitted from GSFC via communications satellite to the EROS Data Center where geometric corrections will be applied and film will be created for archival and user product generation.

Landsat D thematic mapper (TM) data products will not be generally available until much later. Current plans are to achieve a research and development (R&D) output capability of 12 scenes per day about 1 year after launch, and an operational production output capability of 50 scenes per day by January 1985. The standard data product sent to EDC for archival and product generation will be fully corrected film. A 48-hour turnaround at GSFC is

[1]The MSS on Landsat 3 was designed to gather data from a fifth, thermal-infrared band. Very few data were obtained, however, and for practical reasons "band 8" is considered never to have existed.

planned, just as with MSS products. Digital TM data in the form of CCT's will be shipped to EDC for reproduction based on user demand.

The longer lead time needed for operational output of TM data is influenced primarily by two factors: (1) the TM Image Processing System within the IGF will not achieve a significant fraction of the eventual operational requirement until approximately 1 year after launch, and (2) algorithms to compensate for possible "jitter" effects (from the TM mirror) on band-to-band registration and geometric correction can not be finalized until after the satellite is launched and the magnitude of the high frequency vibrations is quantified.

These projected production goals apply to U.S.-acquired data only. The Landsat D spacecraft itself will be capable of supporting real-time acquisitions of many more scenes of data by both U.S. and non-U.S. stations. A maximum of 660 scenes per day of MSS data and 250 scenes per day of TM data could potentially be acquired on a worldwide basis.

On or about January 1983, when full capability for MSS data production is proven, the National Oceanic and Atmospheric Administration (NOAA) will assume operational responsibility for the MSS segment of the Landsat D mission. A similar transition of responsibility is expected in January 1985 when the capability for producing TM data products has been established.

MSS ACQUISITION REQUESTS TO BE HANDLED BY EDC

When the Landsat D MSS becomes operational, acquisitions by the MSS sensor will be scheduled in large part in response to user requests. These requests will be received by EDC, who will consolidate all requirements for specific MSS scenes, handle the associated billing and accounting functions, and forward the acquisition requirements to the Goddard Space Flight Center for scheduling.

Implementation of this system will represent a significant change in acquisition philosophy in that it will give first priority to those users who have specific scene requirements and are willing to bear the cost of acquiring these scenes. Past acquisition policies have included routine collection of data over many areas where user demand has not justified acquisition costs. For a special acquisition fee, users will now be able to request specific dates and areas of coverage, as well as specify such parameters as maximum acceptable cloud cover, compression mode, gain, and others.

Any remaining MSS acquisition capacity will be used as much as possible to collect additional data which, although not specifically ordered in advance, would constitute a Basic Data Set of scenes deemed likely to be purchased at some future time.

EDC's User Services Section is currently designing a system for handling these customer-specified acquisition requests. Details on how the system will work, and what options will be available to Landsat users upon its implementation, will be covered in the next issue of this newsletter.

CCT VERIFICATION PRINTS DISCONTINUED

Effective May 1, 1982, CCT verification imagery will no longer be provided by EDC with CCT orders.

CCT customers in the past have received, in addition to their magnetic tape, a photographic print of the area represented on the tape. A band 5 image was included with orders for MSS CCT's; a print of the applicable subscene accompanied RBV CCT's. These prints will no longer be provided automatically.

Customers desiring verification imagery with their CCT's after May 1, 1982, are advised that all such photographic prints (film or paper) must be requested as a separate order and that standard product prices will apply.

LATE PAYMENT POLICY

As directed by the Department of the Interior, the U.S. Geological Survey is required to charge interest on customer accounts not paid within 30 days of the billing date. Interest rates are determined by the U.S. Department of the Treasury on a quarterly basis.

This policy will go into effect on April 1, 1982. The annual rate for the period of April 1, 1982, through June 30, 1982, has been set at 13.22 percent.

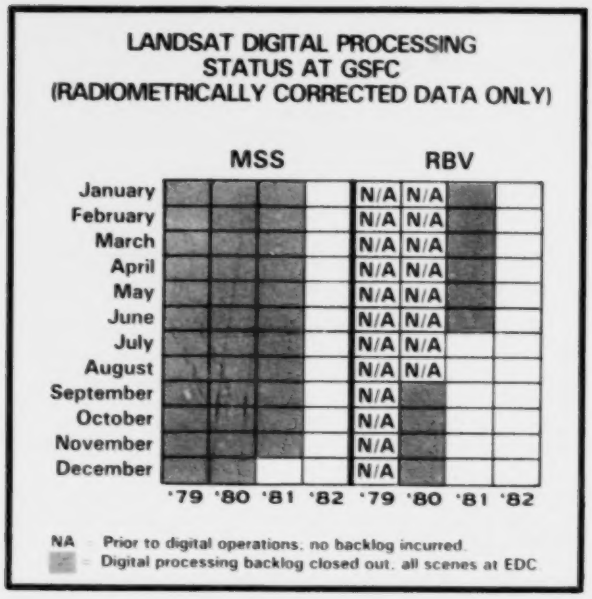
EDC customers should be aware of this if they are currently carrying a delinquent bill for any products purchased. Questions can be directed to the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6509.

Notice of any changes in the interest rate will be published in this newsletter.

STATUS OF GSFC DIGITAL PROCESSING

Because of various ground system problems that occurred after the commencement of digital operations between GSFC and EDC in 1979, the flow of Landsat data to EDC was frequently interrupted even though acquisitions by the satellites were continuing. This situation resulted in a large backlog of data waiting to be processed at GSFC, and it was not until recently that any substantial progress could be made toward eliminating it.

In the past year, this backlog of Landsat digital processing has been significantly reduced, and certain monthly increments of data have been "closed out." The progress is shown by the shaded areas in the chart below. When a month is closed out, it means that all processable Landsat MSS and RBV scenes acquired during that month have been proccessed and sent to EDC. The chart was current as of March 1, 1982. It should be noted that digital processing of RBV data did not start until September 1980.



PROCEEDINGS OF PECORA VII

The Proceedings of the Pecora VII Symposium, held in Sioux Falls, S. Dak., October 18-21, 1981, are now available from the American Society of Photogrammetry. The 632-page volume includes papers on a variety of topics dealing with the symposium's theme: "Remote Sensing: An Input to Geographic Information Systems in the 1980's." Interested parties should place their order with Mrs. Engel, American Society of Photogrammetry, 105 N. Virginia Ave., Falls Church, VA 22046. The price is $27.50. A $1 handling charge for U.S. orders and a $3 handling charge for non-U.S. orders should be included with your remittance.

DIGITAL ANALYSIS COURSE TO BE HELD

The EROS Data Center will offer a "Digital Land Cover Classification Techniques" training course at EDC on June 7-11, 1982. This specialized course, emphasizing both conventional and advanced digital classification procedures, is designed for resource and remote sensing specialists. An understanding of the fundamentals of remote sensing and the digital analysis process is requisite. For further information, contact the Chief, Training and Assistance, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198.

WORKSHOP SERIES ON GEOGRAPHIC INFORMATION ANALYSIS

Yale University has announced a series of four 2-day workshops that will be held this spring on the subject of geographic information analysis. Each workshop will have the same basic content and structure but will be held at a different location. The schedule and host organization are as follows:

March 13-14	Colorado State University College of Forestry and Natural Resources Fort Collins, CO 80523
June 1-2	Yale University School of Forestry and Environmental Studies New Haven, CT 06511
June 23-24	Oregon State University Department of Resource Recreation Management Corvallis, OR 97331
July 10-11	Purdue University Continuing Education Administration West Lafayette, IN 47907

The workshops will focus on the fundamental operations, advantages, and constraints of computer-aided map analysis. The curriculum will be limited. Interested parties should apply to the "Geographic Information Analysis Coordinator" at one of the addresses given above for further information and/or enrollment materials.

EDC TRAINING SCHEDULE

June 7-11	**Digital Land Cover Classification Techniques** (Sioux Falls, S.Dak.) Open enrollment. Advanced course; see separate notice elsewhere in these pages. Contact: Chief, Training and Assistance Branch, Office of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.
June 21-25	**Terrain Analysis: Interpretation of Aerial Photographs and Images** (Sioux Falls, S. Dak.) Contact: Coordinator, Continuing Education Program, Harvard Graduate School of Design, Gund Hall, L-37, Harvard University, Cambridge, MA 02138, telephone: (617) 495-2578.
Aug. 30-Oct. 1	**International Remote Sensing Workshop: Applications in Vegetation Assessment and Land Use Planning** (Sioux Falls, S. Dak.) Open to non-U.S. scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092, telephone: (703) 860-6418.

ADDITIONAL TRAINING IN REMOTE SENSING

May 24-28 **Synthetic Aperture Radar with Remote Sensing Applications** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington University, Washington, D.C. 20052, telephone: (202) 676-6106.

June 7-11 **Applied Remote Sensing for Terrain Analysis** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington University, Washington, D.C. 20052, telephone: (202) 676-6106.

June 27-July 2 **5th Annual Vegetation Remote Sensing Workshop** (Glen Arbor, Mich.) Contact: Dr. C. E. Olson, Jr., School of Natural Resources University of Michigan, Ann Arbor, MI 48109, telephone: (313) 764-1413

July 5-9 **Remote Sensing and Aerospace Technology for Teachers** (Edmonton, Alberta) Contact: Dr. Joe Kirman, Project Omega, Faculty of Education, University of Alberta, Edmonton, Alberta T6G 2G5, Canada, telephone: (403) 432-4273.

July 12-16 **Short Course in Numerical Analysis of Remote Sensing Data: Crop Inventory** (West Lafayette, Ind.) Contact: D. B. Morrison, Laboratory for Applications of Remote Sensing (LARS), Purdue University, 1220 Potter Drive, West Lafayette, IN 47906, telephone: (317) 494-6305.

CCT USERS, PLEASE NOTE:

The conversion of selected 1972 data from wideband video tape to CCT's will be completed within the next few months. Starting on August 1, 1982, all 1972 acquired wideband video tapes will be retired from the GSFC archive. No further conversion of those data to CCT's will be possible after that date, although the film archive will remain intact. Therefore, if you need to order CCT's of any of these 1972 data, your order must be placed with EDC before July 1, 1982.

EDC LANDSAT PRODUCTION STATISTICS

	Aug. '81 MSS	Aug. '81 RBV	Sept. '81 MSS	Sept. '81 RBV	Oct. '81 MSS	Oct. '81 RBV	Nov. '81 MSS	Nov. '81 RBV	Dec. '81 MSS	Dec. '81 RBV	Jan. '82 MSS	Jan. '82 RBV	6-Month Total MSS	6-Month Total RBV
Landsat scenes acquired (satellite acquisitions)*	3,311	504	2,764	898	2,585	534	2,186	170	1,464	411	1,191	408	13,501	2,923
Landsat MSS scenes/RBV subscenes received at EDC	3,519	2,672	4,036	1,132	3,486	2,403	3,620	1,081	2,464	2,735	1,500	3,650	18,625	13,673
Average time in days from EDC receipt to archive availability	19.8	21.9	20.6	18.1	9.3	35.4	32.6	13.9	22.8	14.0	31.1	9.6	–	–
Average delivery time from receipt of order at EDC to shipment:														
Standard photographic products	12		13		17		20		20		17		–	
Standard digital products**	8		9		15		14		14		9		–	
Landsat photographic frames sold	10,187		7,654		16,678		7,991		8,258		7,117		57,885	
Landsat digital scenes sold	430		363		940		542		351		208		2,834	
TOTAL LANDSAT DOLLAR VOLUME	$219,857		$160,268		$374,922		$224,486		$221,788		$182,828		$1,384,149	

*Figures are revised periodically to reflect updated information received from NASA.
**Standard digital products average 3 days in production – balance of turnaround is for 9-in. prints shipped with the tapes.

The Landsat Data Users NOTES is published bimonthly in order to present information of interest to the user community regarding Landsat products, systems, and related remote sensing developments. There is no subscription charge; individuals and organizations wishing to receive the NOTES should contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, U.S.A., telephone: (605)594-6151.

Comments, corrections, and other inquiries should be directed to:

Editor, Landsat NOTES
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198

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LANDSAT 4

The Landsat satellites have been a valuable and prolific source of remotely sensed Earth resource data since the first Landsat was launched in July 1972. Although use of the data grew gradually at first, researchers made considerable progress in a relatively short time. As processing and information extraction techniques became more advanced, the application of Landsat data to practical problems in resource monitoring and management expanded greatly. Two more satellites were launched in 1975 and 1978, enabling this work to continue.

Today, 11 nations worldwide have the capability to directly receive and process data from Landsat. In addition, more than 100 nations now make serious use of Landsat data for resource evaluation and management. The practical applications of Landsat data are found in such activities as oil and mineral exploration, agriculture, land use monitoring and planning, forestry, range management, water management, and map making.

To date, however, the Landsat program has officially been an experimental effort. The same basic sensor package has been flown aboard the three Landsats orbited since 1972, and the methods by which the sensor data are transformed into user products, originally designed for research and development activities, continue to be time consuming and at times unreliable.

An operational, second-generation, Earth-sensing capability will be brought into use this summer after nearly a decade of developmental effort. This new system is known as Landsat 4, and it was launched on July 16, 1982.

The impetus for the Landsat 4 program came primarily from the recognition of certain limitations in the performance of the multispectral scanner (MSS) sensing instrument, the primary sensor aboard every Landsat since 1972. A new sensor system with improved spatial resolution, spectral separation, geometric fidelity, and radiometric accuracy was needed and therefore became the subject of a design effort initiated in the early 1970's. This effort has been in the execution phase since 1977. The second-generation, improved, Earth-observing sensor that emerged is called the thematic mapper (TM).

The TM relies heavily on the technology of the first-generation sensor, the MSS, but it achieves many improvements in capability which will add substantially to the effectiveness with which Landsat data can be used. A four-band MSS, similar to those flown before, is also carried on Landsat 4 and will collect data simultaneously with the TM. The two sensors, along with a vastly improved ground processing capability, will form a complete, highly automated data gathering system designed to serve the remote sensing community for the remainder of this decade.

Five major objectives for the Landsat 4 program have been identified by the National Aeronautics and Space Administration (NASA):

1. To assess the capability of the TM, and its associated ground systems, to provide improved information for Earth resources management.
2. To provide for continued availability of MSS data.
3. To provide a transition from MSS data to the higher resolution and data rate of the TM.
4. To provide for system-level feasibility demonstrations to define the characteristics of an operational land satellite system, including transfer of Landsat 4 management from NASA to the National Oceanic and Atmospheric Administration (NOAA).
5. To permit continued reception of Landsat data by other nations.

This issue of the Landsat Data Users NOTES includes a special review of the major elements of the Landsat 4 system.

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Landsat Data Users NOTES

ISSUE NO. 23
JULY 1982

NASA

U.S. GEOLOGICAL SURVEY
EROS DATA CENTER
Sioux Falls, S. Dak. 57198

SPACECRAFT

The overall Landsat 4 system is considerably more complex than the Landsat 1, 2, and 3 systems (an exploded view of the spacecraft is provided on this page). Not only is Landsat 4's Earth coverage pattern different, but it is designed to interact with a number of other satellite systems for data relay, communications, and orbit control.

The observation platform is NASA's Multimission Modular Spacecraft (MMS), which provides power, altitude and attitude control, and onboard command and data handling. The MMS has an improved attitude-control capability over that of previous Landsat systems. The pointing accuracy is specified to be within 0.01 degree (1 sigma), and the stability is specified to be within 10^{-6} degree/second (1 sigma). These values compare with the 0.7-degree pointing accuracy and 0.01-degree/second stability associated with Landats 1 through 3. In addition, the attitude control system information provided by the MMS is supplemented by an angular displacement sensor mounted on the TM. The angular displacement sensor provides the more precise information that may be needed to account for the effects of vibration (jitter) on the image data. The MMS is also designed for retrieval by the Space Shuttle.

Another major advance in the Landsat 4 system is represented in its capability to communicate with the new Tracking and Data Relay Satellite (TDRS) system which is scheduled to begin deployment in 1983. The TDRS vehicles will relay data from the satellite to Earth in near-real time, thus eliminating the need to rely upon onboard tape recorders, which have had limited lifetimes on previous Landsat missions.

The TDRS antenna located on the Landsat 4 spacecraft will permit command signals, telemetry signals, and TM and MSS sensor observations to be relayed, through one of the two TDRS satellites in geostationary orbit, to a single ground receiving station at White Sands, N. Mex. To handle the high data communication rates that are employed by Landsat 4, as well as other spacecraft served by TDRS, the TDRS system will use a Ku-band frequency for communications to the ground. This frequency will support simultaneous transmission of both TM and MSS data.

A domestic communications satellite (DOMSAT) system will be used to transmit sensor data from White Sands to the data processing facility at the Goddard Space Flight Center (GSFC) in Greenbelt, Md., and subsequently to the Landsat data distribution center at the Earth Resources Observation Systems (EROS) Data Center in Sioux Falls, S. Dak.

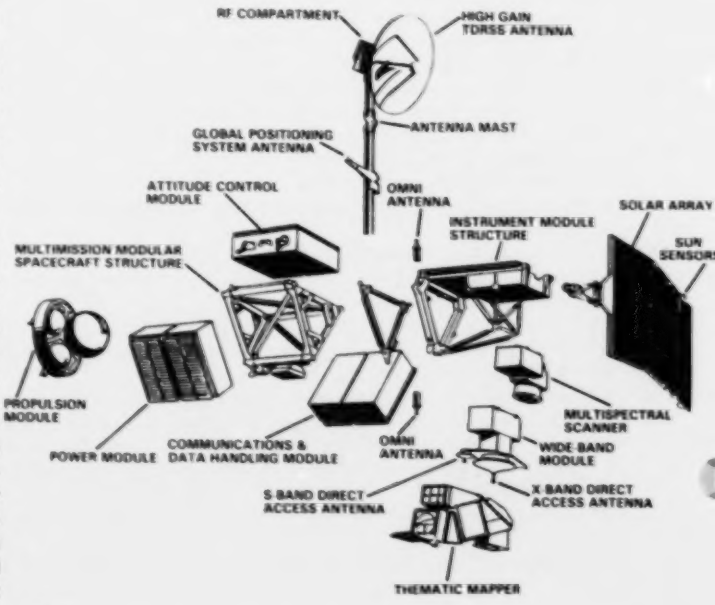
In addition to the roles of the TDRS and DOMSAT systems, Global Positioning System (GPS) navigation satellites are expected to provide Landsat 4 with highly accurate position and velocity data. These data will be used both on board Landsat 4 and on the ground, where downlinked data could be used for geometric correction of TM and MSS imagery. Only 5 of the 18 GPS satellites that are planned, however, will be in orbit in the early 1980's.

A diagram depicting all the satellites with which Landsat 4 will interact is provided on page 3.

The Landsat 4 spacecraft is also able to communicate with, and send data directly to, in-range ground receiving stations worldwide. For this purpose, X-band frequencies will be used for handling the TM and MSS data streams. Those stations not equipped to receive X-band transmissions will be able to obtain only MSS data in real-time, using an S-band frequency as have previous Landsats.

Delays in the deployment of the TDRS system are expected to significantly limit the amount of TM data that can be acquired by this means during the early phases of the Landsat 4 mission. A transportable ground station located at GSFC has therefore been provided to allow real-time TM data acquisition over the eastern United States, to approximately 100°. W. longitude. TM data acquisition capabilities for the remainder of the United States will be provided following the deployment of the first TDRS vehicle (anticipated in early 1983). Landsat 4 MSS data will be acquired through the existing U.S. ground station network and selected non-U.S. stations until the TDRS system is fully operational.

From Goddard, radiometrically corrected MSS data in digital form will be relayed, again via DOMSAT, to the EROS Data Center (EDC). There, the data will be processed into master reproducible 241-mm (9-inch) film negatives, and stored in the form of high-density digital tapes (HDT's). No satellite transmissions of TM data between Goddard and EDC are planned. TM products will be in the form of 241-mm film and computer-compatible tapes (CCT's) produced at GSFC and will be shipped by air freight to the EDC distribution facility.



The structure of the Landsat 4 spacecraft is characterized by its large deployed mast which supports the TDRS antenna and by its single-wing solar array. The long dimension of the spacecraft body (the roll axis) lies in the plane of the orbit, the yaw axis is oriented to the local vertical (parallel to the antenna mast), and the pitch axis is normal to the orbit plane and parallel to the axis of rotation of the solar array.

The principal sensing instruments, the TM and the MSS, are located at the forward end of the instrument module. Each sensing instrument uses a moving mirror assembly to scan in the crosstrack direction (perpendicular to the spacecraft ground track) and depends upon the relative motion of the spacecraft to achieve the along-track scan.

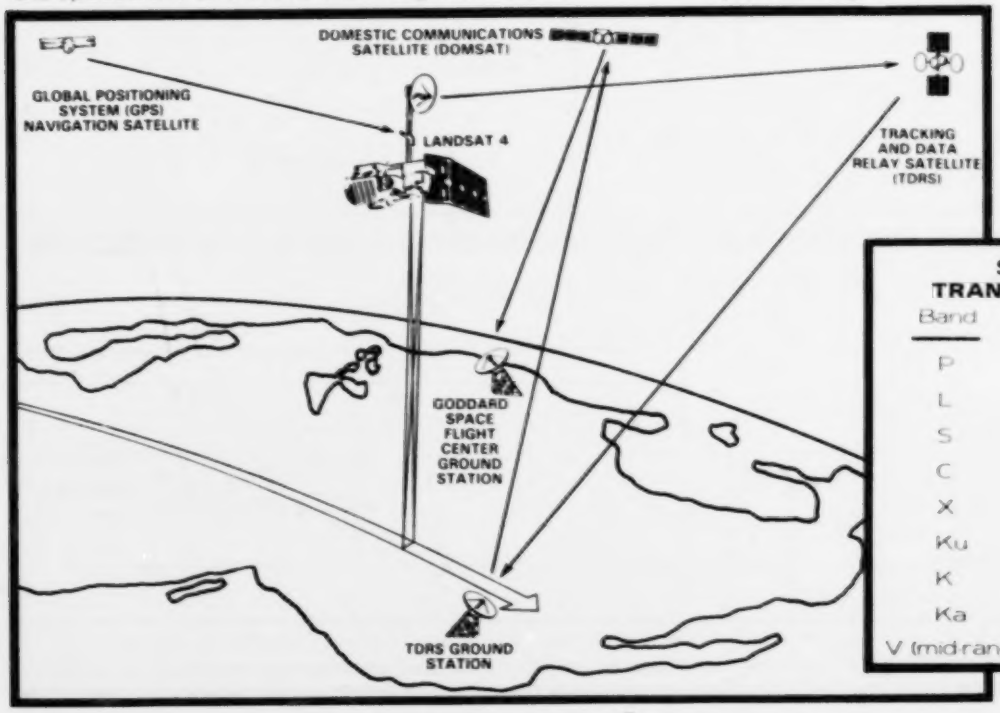
SENSORS

In terms of basic design, there are at least two fundamental differences between the MSS and TM. First, the TM scans and obtains data in both directions. The bidirectional approach was employed to reduce the scan rate and provide the dwell time needed to produce improved radiometric accuracy. Second, the TM detector arrays are located within the primary focal plane of the instrument, allowing incoming light to be reflected directly onto the detectors without transmission through fiber optics, as with the MSS. This configuration minimizes any loss in the intensity of incoming radiation. However, it requires that the detector arrays for various spectral bandwidths be spaced apart in the focal plane by the equivalent of several raster lines, meaning that the same point on the ground is not simultaneously scanned in all seven bands. Accurate TM band-to-band registration will thus depend on precise time registration and scan mirror profile linearity and repeatability.

Thematic Mapper

The TM operates in seven spectral bands. The selection of bands for this sensor was the subject of considerable study and debate. The band designations, spectral ranges, and principal applications are as follows:

- Band 1 (0.45-0.52 μm)
  Designed for water body penetration, making it useful for coastal water mapping. Also useful for differentiation of soil from vegetation, and deciduous from coniferous flora.
- Band 2 (0.52-0.60 μm)
  Designed to measure visible green reflectance peak of vegetation for vigor assessment.


DOMESTIC COMMUNICATIONS SATELLITE (DOMSAT)
GLOBAL POSITIONING SYSTEM (GPS) NAVIGATION SATELLITE
LANDSAT 4
TRACKING AND DATA RELAY SATELLITE (TDRS)
GODDARD SPACE FLIGHT CENTER GROUND STATION
TDRS GROUND STATION

SATELLITE TRANSMISSION BANDS

Band	Frequency (GHz)
P	0.3 - 1.0
L	1.0 - 2.0
S	2.0 - 4.0
C	4.0 - 8.0
X	8.0 - 12.5
Ku	12.5 - 18.0
K	18.0 - 26.5
Ka	26.5 - 40.0
V (mid-range)	50

- Band 3 (0.63-0.69 μm)
  A chlorophyll absorption band important for vegetation discrimination.
- Band 4 (0.76-0.90 μm)
  Useful for determining biomass content and for delineation of water bodies.
- Band 5 (1.55-1.75 μm)
  Indicative of vegetation moisture content and soil moisture. Also useful for differentiation of snow from clouds.
- Band 6 (10.40-12.50 μm)
  A thermal infrared band of use in vegetation stress analysis, soil moisture discrimination, and thermal mapping.
- Band 7 (2.08-2.35 μm)
  A band selected for its potential for discriminating rock types and for hydrothermal mapping.

These spectral bands were chosen primarily for vegetation monitoring. The one exception is band 7, which was added primarily for geological applications.

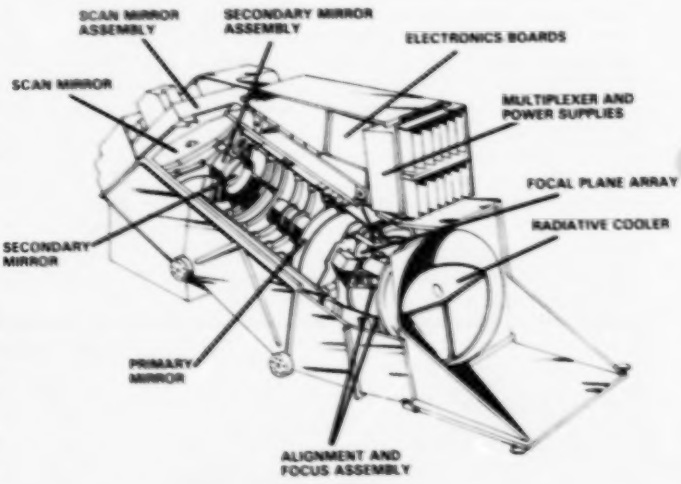
An important design goal was the achievement of better radiometric sensitivity in all bands. The radiometric sensitivity of the TM (table 1) is much improved over that of the MSS, even though the TM spectral bandwidths are narrower and the ground sample size (pixel size) is smaller. In conjunction with this improvement, the number of quantization levels has been increased from 64 to 256.

Improved spatial resolution (over that of the MSS) is another attribute of the TM. A pixel size of 30 m (ground resolution) in all but band 6 will allow classification of areas as small as 2½ to 4 ha (6 to 10 acres). Band 6, a thermal band, will achieve a pixel size of 120 m on the ground.

These performance levels were determined by such factors as: (1) the detector instantaneous field of view (IFOV), which is a function of detector size and focal length of the telescope; (2) the optics of the telescope and the scan mirror, which were designed to minimize diffraction and blur; and (3) the electronic frequency response of the system, which was dictated by the dwell time afforded by other components of the system. Summaries of anticipated TM performance parameters are given in tables 2 and 3.

As shown in the accompanying cutaway diagram, the TM is mounted in the spacecraft in a horizontal position with the sun shade pointing toward Earth. Directly above the sun shade aperture is a scan mirror surrounded by its drive mechanisms, control electronics, and scan monitor hardware. The primary mirror is mounted about halfway down the length of the telescope, preceded by optical baffling and the secondary mirror. Directly behind the primary mirror are the scan line corrector, internal calibrator, and the visible detector focal plane with its mounting hardware and alignment mechanisms. The radiative cooler (containing the cooled focal plane assembly), relay optics, and infrared detector arrays are located on the instrument's aft end. The electronics package is contained in a wedge-shaped box above the telescope and contains the multiplexer, power supplies, signal amplifiers, and filters for all channels.

The detector assemblies for spectral bands 1-4 are located at the primary focal plane and employ 16 detectors for each band. The detector assemblies at the cooled focal plane consist of two



Thematic Mapper

TABLE 1
Thematic Mapper Radiometric Sensitivity

Effective Aperture: 1063 cm²
Effective Quantizer Bits: 7.75

Band	Optical Transmission	Responsivity (A/W)	Fixed Noise (pA)	Signal to Noise Ratio (S/N)			
				Minimum Scene Radiance		Maximum Scene Radiance	
				Specified	Actual*	Specified	Actual*
1	0.77	0.33	2.3	32	52	85	143
2	0.77	0.40	2.3	35	60	170	279
3	0.90	0.45	2.1	26	48	143	248
4	0.76	0.56	2.2	32	35	240	342
5	0.69	1.2	4.9	13	40	75	194
7	0.65	1.6	4.8	5	21	45	164
6	0.53	15 kV/W		**NETD 0.5K	0.13K		

*"Actual" ratios are based on initial calculations only and may be subject to refinement as reduction of observed test data continues.
**NETD = Noise equivalent temperature difference

high-resolution, near-infrared bands (5 and 7) with 16 detectors each, and one thermal band (band 6) with four detectors. Thus, during each scan mirror sweep, 16 scan lines of data are generated for each of bands 1-5 and 7, and four are generated for band 6.

A scan angle monitor on the scan mirror passes signals to the timing mechanism in the multiplexer to indicate the beginning, midscan, and end of the period in the scan mirror's travel when data are taken in the forward scan direction. Equivalent signals are provided for the beginning, midscan, and end of the reverse scan. A "line stop" signal at the end of each scan (both forward and reverse) indicates the end of the formatting period and is buffered and retransmitted to the scan line corrector to initiate motions which correct for overlap.

The scan line corrector, located in front of the prime focal plane, rotates the TM line-of-sight backward along the ground track to generate scan lines which are straight and perpendicular to the ground track. During each turnaround period of the scan mirror, the internal calibrator stimulates the individual channel voltages for all seven spectral bands, providing for routine monitoring of detector condition for use in ground processing of the image.

The TM collects radiometric data in the seven spectral bands by utilizing the detector assemblies of the primary focal plane array and the cold focal plane array. As the scan mirror sweeps the TM line-of-sight back and forth seven times per second in a direction normal to the ground track, it forms a raster of 16 lines in bands 1-5 and 7, and 4 lines in band 6, for each sweep direction. Data are collected during both the forward (west-to-east)

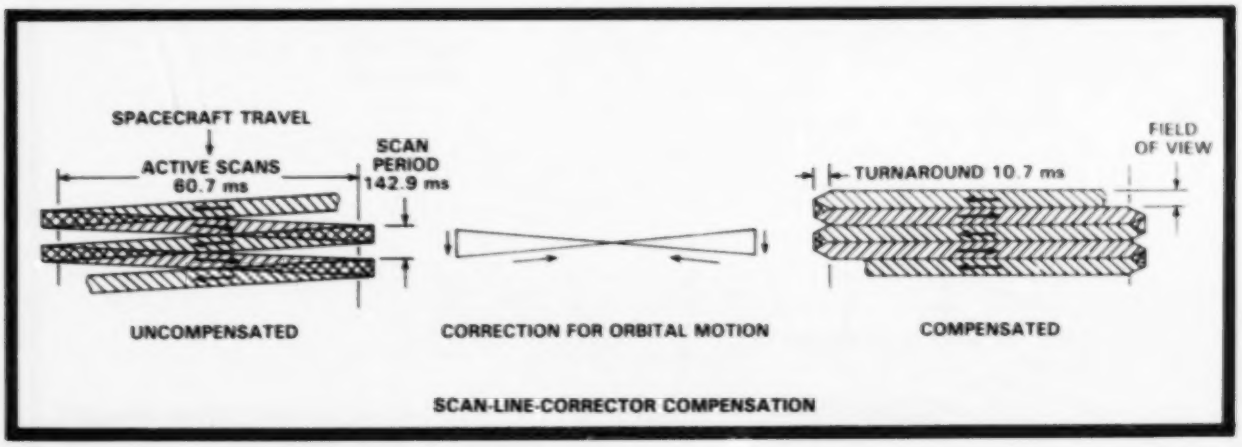
TABLE 2
Significant Thematic Mapper Parameters

Orbit:	Sun Synchronous 705.3 km Altitude 98.9 min Period 98.2° Inclination 16-day Repeat Cycle
Scan:	185 km Swath 7.0 Hz Rate 85 percent Efficiency
Optics:	40.6 cm Aperture f/6 at Prime Focus 42.5 μrad IFOV, Bands 1-4 f/3 at Relay Focus 43.8 μrad IFOV, Bands 5,7 170 μrad IFOV, Band 6
Signal:	52 kHz, 3 dB, Bands 1-5, 7 13 kHz, 3 dB, Band 6 1 Sample/IFOV 8 Bits/Sample 84.9 Mbps Multiplexed Output

TABLE 3
Major Performance Requirements of the Thematic Mapper

Square Wave Response (Bands 1-5, 7)	[illegible]
Band-to-Band Registration	<[illegible]
Scan Profile Repeatability	<[illegible]
Along-Track Overlap/Underlap	<[illegible]
Swath Width	[illegible]
Radiometric Resolution:	
(Bands 1-5, 7)	[illegible]
(Band 6)	[illegible]
Absolute Radiometric Accuracy	[illegible]
Band-to-Band Radiometric Precision	[illegible]
Channel-to-Channel Radiometric Precision	[illegible]
Spectral Coverage	[illegible]
Signal Quantization Levels	[illegible]
Data Rate	[illegible]
Weight	[illegible]
Power	[illegible]
Envelope	[illegible]

*$NE\rho$ = Noise-equivalent reflectance.
**NEΔT = Noise-equivalent temperature difference.



SCAN-LINE-CORRECTOR COMPENSATION

and reverse (east-to-west) scans. The Ritchey-Chretein telescope images the scanned scene energy onto the prime focal plane as the scan line corrector is operating to provide forward and reverse scan swaths adjacent to each other. At the prime focal plane, each band (bands 1-4) employs a 16-element detector array to translate the sensed scene energy into low-level electrical signals which are amplified, converted to 8-bit digital words, and then multiplexed into an 84.9-megabit-per-second (Mbps) data stream which is transmitted to the ground. A two-mirror, all-reflective relay reimages the incoming energy from bands 5, 6, and 7 onto the cooled focal plane located in the radiative cooler. At the cooled focal plane also, energy is converted into low-level electrical signals, amplified, and translated into 8-bit digital words which are multiplexed into an 84.9-Mbps data stream for transmission to the ground.

Multispectral Scanner

The MSS on Landsat 4 is similar to the MSS instruments that were flown on Landsats 1, 2, and 3. However, in order to provide MSS data compatible with that acquired from the higher orbits flown by Landsats 1, 2, and 3 (about 920 km), the optics of the Landsat 4 MSS system have been adjusted so that the pixel size still approximates an 80-m ground area. In addition, a new numbering system is being used to designate the four spectral bands of the Landsat 4 MSS. What are known as bands 4, 5, 6, and 7 on the previous MSS sensors, are now known, respectively, as Landsat 4 MSS bands 1, 2, 3, and 4. This is a change in designation only. The spectral coverage of the instrument will remain the same.

ORBIT AND COVERAGE

Landsat 4 is expected to assume a repetitive, circular, Sun-synchronous, near-polar orbit at a nominal altitude of 705 km (431 mi) over the equator. The satellite will cross the equator at approximately 9:45 a.m. on each pass. Each orbit will take nearly 99 minutes, and the spacecraft will complete just over 14½ orbits per day, covering the entire Earth (poles excepted) every 16 days. Major orbital characteristics are shown in the diagram below.

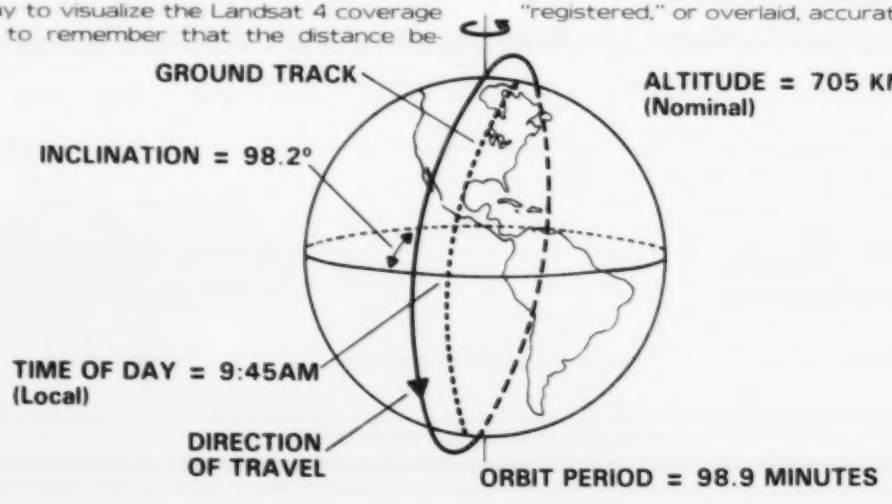
This compares to the similar but higher orbits of Landsats 1, 2, and 3, which had altitudes of 920 km (570 mi), completed each orbit in 103 minutes (14 times a day), and covered the Earth every 18 days.

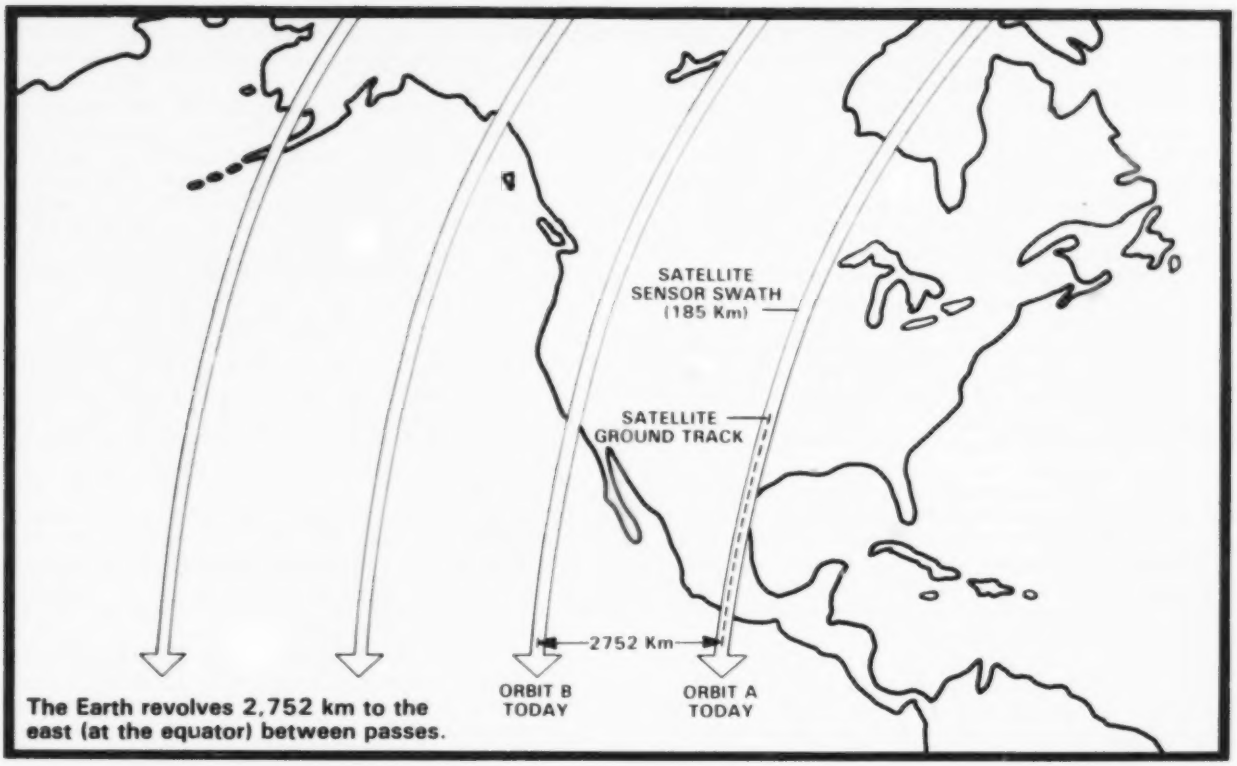
The lower orbit of Landsat 4—necessary for the 30-m ground resolution of thematic mapper data—results in an Earth coverage cycle significantly different from that of the earlier Landsats. For Landsat 4, the adjacent swath to the west of a previous swath is covered 7 days later. This is in contrast to Landsats 1, 2, and 3, where the adjacent swath to the west was established just 1 day later. A convenient way to visualize the Landsat 4 coverage pattern is to remember that the distance between any two consecutive orbits (moving westward) is 2,752 km at the equator. The rest of the area between these ground tracks fills in over a 16-day period, whereupon the coverage pattern starts repeating itself.

At the equator, adjacent swaths overlap at the edges by 7.6 percent. Moving from the equator toward either pole, this "sidelap" increases because of the fixed swath width of 185 km.

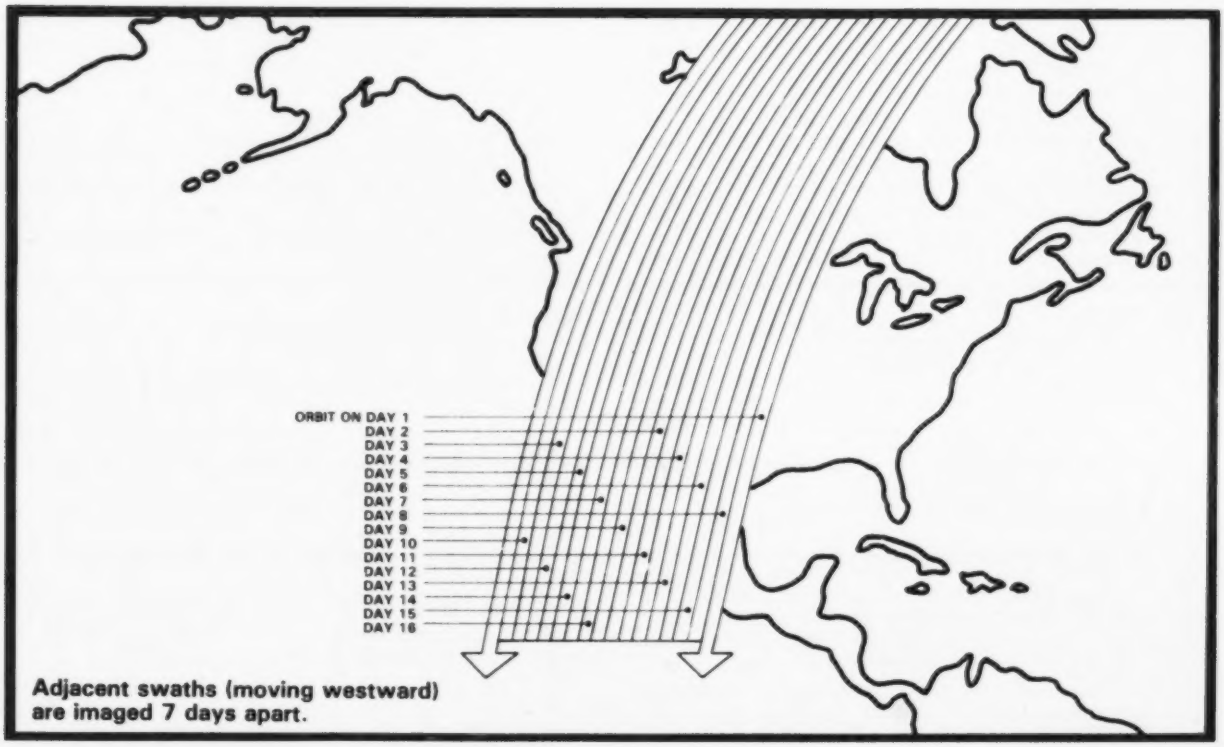
The Landsat 4 16-day ground coverge cycle is accomplished in 233 orbits, making it incompatible with the 251-orbit Worldwide Reference System (WRS) path/row indexing scheme that is used with data from previous Landsats. The WRS path/row system for Landsat 4 is made up of 233 paths numbered from 001 to 233, east to west, with path 001 crossing the equator at 64.95° W. longitude. The same number of rows, however, are still used. The rows are positioned so that row 60 coincides with the equator at the orbit's descending node, there being 248 rows in all.

Successive orbits and framing operations will be carefully controlled to ensure minimal variation to either side from the intended ground track and precise framing from top to bottom so that successive images of a specific scene can be "registered," or overlaid, accurately.





The Earth revolves 2,752 km to the east (at the equator) between passes.



Adjacent swaths (moving westward) are imaged 7 days apart.

GROUND SEGMENT

The Landsat 4 ground segment activity can be divided into two parts, one representing the facilities and preprocessing performed at Goddard and the other representing the final processing and distribution of data at EDC. A chart showing significant milestones for the ground segment over the next few years is provided below.

Goddard Space Flight Center

The Goddard portion of the ground segment consists of a Control and Simulation Facility, a Mission Management Facility, an Image Generation Facility, a Landsat Assessment System, and the Transportable Ground Station. The Image Generation Facility (IGF) is the most important of these, from the user's point of view, for here is where the raw instrument data from the satellite are processed toward final products for distribution.

The IGF receives and processes raw instrument data to produce film and digital Landsat data products from both the MSS and TM sensor systems. Importantly, there are two distinct image processing subsystems to provide for complete separability of TM and MSS processing. By doing this, the flow of MSS data to the user community can be maintained without being affected by the data processing research and development that will be going on (for at least the first year) with TM data. The computer systems used to process both types of data also incorporate a high degree of redundancy to maximize processing reliability.

The MSS element of the IGF was scheduled to become operational 14 days after launch. The TM element will function initially in a research and development mode and will subsequently evolve into an operational system after the TM sensor and its performance are characterized.

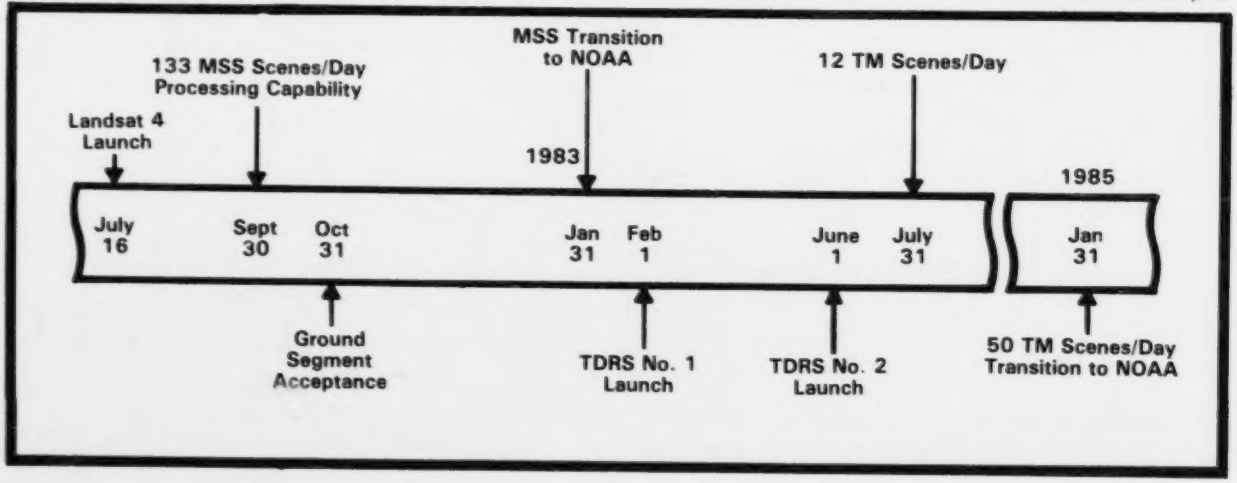
Within the IGF, MSS data are to be produced at a rate of about 133 scenes per day during the first months of operation, and it will be possible to increase this rate to 200 scenes per day if demand warrants. These preprocessed data will be in the form of radiometrically corrected, high-density digital tapes (HDT-A's). The HDT-A data will be transmitted via DOMSAT to the EROS Data Center, at Sioux Falls, S. Dak., where geometric corrections will be applied and various user products in both digital and film format will be produced.

The acquisition, processing, and distribution of TM data will be more complex, primarily due to the increased data output of the sensor and its associated ground systems. The need to perform engineering assessments and validations, and the fact that it is not possible to implement a full TM processing capability prior to launch, are also factors. Operational output of TM data products is not expected until January 1985.

In the first year after launch, TM data will be acquired primarily over the United States at a rate of 30 scenes per day and will be stored at GSFC for processing in the event of early failure of the TM. From these 30 scenes, TM data will be processed at GSFC at a rate of approximately 1 scene per day. These data will be produced in the form of: (1) 241-mm black-and-white paper prints and film transparencies for each of the seven bands of the TM; (2) false-color composites made from bands 2, 3, and 4; and (3) computer-compatible tapes.

These data will be used to evaluate the performance of the TM and will be a close approximation, in terms of format, to the standard products to be eventually produced by the TM Image Processing System (TIPS) within the IGF. The TIPS will begin operation in July 1983. Sample data acquired in the first year, before the TIPS is operational, will be distributed to EDC to permit the availability of at least a limited amount of TM scene data. These products will be available no earlier than approximately 90 days after launch, and distribution will be made only with NASA's concurrence. The price structure for sales of these early data will be announced by NOAA before August 1, 1982.

When the TIPS begins operation, data will be processed at a rate of approximately 12 scenes per day. This will continue until January 1985 when the TM ground processing systems at Goddard and all associated Landsat 4 systems will become the responsibility of NOAA to manage in an operational mode. Fully processed (radiometrically and geometrically corrected) TM data will then be pro-



duced at a rate of about 50 scenes per day.

A paramount concern in the design and development of the Landsat 4 ground segment has been the necessity for generating quality data products in a timely manner. A 48-hour turnaround in the IGF is a design objective, and a high level of "backup" capability using proven data processing components has been incorporated wherever possible. New image generation procedures also allow ample margin for reprocessing a substantial part of the production requirement each day, if necessary, to eliminate errors caught in quality checking.

The radiometric correction procedures have been a subject of key interest. It is expected that, for the MSS, a calibration-wedge approach will be used to assess absolute and band-to-band fidelity during Landsat 4 operation, and scene content histogramming will be used to monitor detector-to-detector gain and bias and to achieve the ±1 quantum level specification. On the TM, a series of three lamps will be operating at different intensities to provide eight levels of calibration intensity over the range of response for the instrument.

The geometric correction specifications for MSS and TM data are quite stringent, especially for the TM. The improved attitude control capability of Landsat 4 may expedite the processing of MSS data in particular. However, the installation of the angular displacement sensor on the TM reflects the concern for the so-called "jitter" effects that can result from the interaction of the scan vibrations produced by the MSS and TM mirrors and the drive mechanisms of the TDRS antenna and the solar array. The information provided by the angular displacement sensor will be used to account for high-frequency vibrations that may affect the band-to-band registration and other geometric specifications already noted.

Corrections by the ground processing system must also be made to account for off-nadir ("bow-tie") effects and scan gap or overlaps in TM data that may occur because of normal variations in orbital altitude.

Algorithms to account for the effects mentioned above, and others, are being developed and will be supplemented to attain the geodetic and temporal registration requirements specified for Landsat 4 data. The selection and use of ground control points will be an integral part of the overall process and will be an especially challenging procedure where the accuracies needed for the TM data become involved. Table 4 summarizes a few of the major performance requirements of the Landsat 4 ground segment.

TABLE 4

Landsat D Ground Segment Performance Requirements

Turnaround:	48 hours after receipt of raw sensor data at GSFC to generation of archival products (worst case averaged over 10 days).
Radiometric error correction (relative interdetector):	±1 quantum level over full range.
Geometric error correction (nominal conditions with ground control points):	0.5 sensor pixel (90 percent of the time with sufficient ground control points that can be correlated).
Temporal registration error:	0.3 sensor pixel (90 percent of the time with sufficient control points that can be correlated).
Map projections supported:	Space Oblique Mercator. Universal Transverse Mercator/ Polar Stereographic.
Resampling algorithms supported:	Cubic convolution or nearest neighbor.

EROS Data Center

The EDC portion of the Landsat 4 ground segment will handle any additional processing of the data not done by Goddard. This includes final formatting of the data into user products, the application of optional corrections and enhancements as specified by users, and the operation of all inquiry, order, accounting, and data base management functions as necessary to maintain a central user archive and data distribution center. One of EDC's new responsibilities in the Landsat 4 period is to receive and process user requests for sensor acquisitions. Some preliminary information on this "special-acquisition" system can be found in the article following this one.

As mentioned earlier, radiometrically corrected MSS scene data in digital form (HDT-A's) will be transmitted via the DOMSAT link from Goddard to EDC as they are now for Landsat 3. Upon receipt, these data will be recorded by 14-track high-density digital tape recorders equipped with error-detection-and-correction circuitry.

The data will then be processed by a computer-based production system called the EROS Digital Image Processing System (EDIPS). EDIPS is a custom-built, real-time data processing system that can read digital image data from HDT's, apply geometric corrections, optionally perform certain kinds of image enhancement processing, and, finally, record the processed data on high-resolution photographic film or standard-density computer-compatible tapes (CCT's). Both types of products, film and tape, are archived at EDC in a central data base from which users can order reproductions.

In the standard processing mode, MSS sensor data are geometrically corrected to remove distortions caused by the sensor scanning mechanism, spacecraft attitude and orbital position variations, aspect ratio, Earth rotation, Earth curvature, and other systematic effects. These corrections are applied using ancillary data provided on the HDT received from Goddard. They permit the image to be conformed to a simple oblique Mercator coordinate system. In the case of Landsat 4, that system will be the Space Oblique Mercator (SOM) projection; the pixel resampling technique used to create this projection will be the cubic convolution technique.

In addition to the geometric corrections, a histogram of pixel brightness values is generated for each image, and an image enhancement algorithm designed to compensate for at-

mospheric scatter (haze) is applied.

Several other enhancements, map projections, and corrections of various kinds are available to the user should a nonstandard product be desired. Usually, orders for either tape or photographic products are completed and shipped within 10 working days after receipt.

When placing an order for a CCT, the user must specify the data type (radiometrically corrected only or both radiometrically and geometrically corrected), the tape bit-density (800-, 1600-, or 6250-bpi), and the scan-line sequence (band-sequential or band interleaved-by-line).

Photographic products are generated from a master film negative printed by the EDIPS laser beam recorder. Black-and-white images, on either film or paper, and false-color composite images are available at a variety of enlargement sizes. All reproduction prints are individually analyzed to select an exposure that will reproduce the majority of image detail within the linear (usable) portion of the tone reproduction curve.

As noted previously, limited amounts of TM data may be made available to the user community beginning approximately 90 days after launch of Landsat D. These data will be in the form of 241-mm (9-in.) photographic prints as well as digital products. Studies are in progress at this time to determine the exact form that standard TM user products will eventually take.

It is currently planned that high-resolution film of fully corrected TM scenes will be shipped by common carrier to EDC for placement in the central archive and generation of reproductions for sale. Digital magnetic tapes in CCT format are also planned, again to be provided by Goddard and distributed to users by EDC.

Inquiries concerning Landsat 4 data products of all types are invited by EDC. Information on format, processing life, availability, price, and other matters of concern to the potential user may be obtained by contacting:

User Services Section
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57298
telephone: (605) 594-6151.

MSS ACQUISITION REQUESTS

When the Landsat 4 MSS becomes operational, acquisitions by the MSS sensor will be scheduled in large part in response to user requests. These requests will be received by EDC, who will consolidate all requirements for specific MSS scenes, handle the associated billing and accounting functions, and forward the acquisition requirements to Goddard for scheduling.

Implementation of this system will represent a significant change in acquisition policy in that it will give first priority to those users who have specified scene requirements and are willing to bear the cost of acquiring these scenes. Any remaining MSS acquisition capacity will be used as much as possible to collect additional data which, although not specifically ordered in advance, would constitute a Basic Data Set of scenes deemed likely to be used at some future time.

The User Services Section at EDC will process the customer's MSS acquisition requests and provide periodic status reports to each customer. Customers will be expected to consider and then furnish the following information when requesting a sensor acquisition:

1. Geographic area of interest, by latitude and longitude.
2. Date(s) of coverage desired
3. Maximum acceptable cloud cover.
4. Data compression mode (compressed or decompressed).
5. Sensor gain (high or low).
6. Type of final products desired after successful acquisition.

Payment sufficient to cover all costs must accompany each request. Refer to issue No. 21 of this newsletter (dated Jan. 1982) for a price list.

EDC's User Services Section will be happy to assist prospective requesters. The telephone number is (605) 594-6151. Written queries may be addressed to:

User Services Section
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198
telephone: (605) 594-6151

THE MSS BASIC DATA SET

Landsat 4 MSS data acquisitions will be partly determined by the requirements of what is known as the MSS Basic Data Set.

The scenes acquired for this Basic Data Set will represent the more routine data collection activities of the satellite. To determine the criteria that should be used to select MSS Basic Data Set scene candidates, NOAA held a series of public meetings this spring to solicit opinions from the user community. NOAA will publish a description of the MSS Basic Data Set late in 1982 in order to inform users of which MSS scenes they can expect to be collected under this program. Although Basic Data Set collections are not guaranteed, NOAA pledges a "best effort" to complete them. The archive of Landsat products thus built will be available for purchase without an initial special-acquisition fee being attached. The coverage provided will also be relatively systematic and repetitive, as long as higher-priority special acquisitions do not preempt system capabilities.

Regardless of how obtained, routine collection or customer-requested, all Landsat MSS data products will be entered into the public domain.

Inquiries regarding MSS Basic Data Set acquisition policy may be addressed to:

National Oceanic and Atmospheric Administration (NOAA)
National Earth Satellite Services
User Affairs Division, Sx32
Federal Building 4, Mail Stop D
Washington, D.C. 20233.

PRINCIPAL INVESTIGATORS SELECTED

To help characterize the performance of the Landsat 4 system and the products obtained from it, an investigator team representing the user community was recently selected to study and document certain areas of special interest. The selections were made based on response to the Landsat D Image Data Quality Analysis (LIDQA) Application Notice issued October 23, 1981 (see issue No. 20 of the NOTES). The 50 proposals that were submitted were individually evaluated by a panel of peers from universities, private industry, and Government agencies. Of these, 24 were provisionally selected for participation in the program.

A list of the investigators and the titles of their proposals are provided below. The LIDQA program will extend, in general, from the time of Landsat 4's launch through January 1985.

PRINCIPLE INVESTIGATOR	AFFILIATION	PROPOSAL TITLE
James Anderson	NASA/Earth Resources Laboratory	Landsat scene-to-scene registration assessment.
Paul Anuta	Purdue University/ Laboratory for Applications of Remote Sensing (LARS)	Research on Landsat D image data quality analysis.
Lee Bender	U.S. Geological Survey	Evaluation of radiometric and geometric characteristics of Landsat D imaging systems.
Ralph Bernstein	IBM Corporation	Landsat D sensor and system data analysis and image science.
Robert Colwell	University of California, Berkeley	Analysis of the quality of image data acquired by the Landsat MSS.
Jeffery Dozier	University of California, Santa Barbara	Landsat D investigations in land cover and snow hydrology.
Jon Erickson	NASA/Johnson Space Center	TM and TM image processing system performance in agricultural applications technique development.
John Everett	Earth Satellite Corporation	Evaluation of Landsat D TM performance as applied to hydrocarbon exploration.
Charlotte Gurney	Systems and Applied Sciences Corporation	The use of linear feature detection to investigate TM data performance and processing.
Charles Hill	NASA/Earth Resources Laboratory	Evaluation of Landsat D TM and MSS resource information requirements.
Warren Hovis	NOAA/National Earth Satellite Service	Development of atmospheric correction procedures and post-launch calibration validation for the Landsat D TM.
Michael Jackson	Natural Environment Research Council, United Kingdom	Spatial analysis of TM products.
Hugh Kieffer	U.S. Geological Survey	Geometric and radiometric characterization of Landsat D TM and MSS data.
Donald Lauer	U.S. Geological Survey	Investigations of TM and MSS data applications.

Robert MacDonald	NASA/Johnson Space Center	Landsat D image data analsyis.
William Malila	Environmental Research Institute of Michigan	Spectral/Radiometric characteristics of the TM.
William Malila	Environmental Research Institute of Michigan	Radiometric consistency of Landsat D MSS.
John Price	U.S. Department of Agriculture/Agricultural Research Service	Information content of data from the Landsat D TM and MSS.
John Schott	Rochester Institute of Technology	Evaluation of the radiometric integrity of Landsat D band 7 data.
Philip Slater	University of Arizona	Spectroradiometric calibration of TM and MSS systems.
W.M. Strome	Canada Centre for Remote Sensing, Canada	Evaluation of Landsat D MSS and TM data.
Roy Welch	University of Georgia	Comparative assessment of Landsat D MSS and TM data quality for mapping applications in the Southeast
Robert Wringley	NASA/Ames Research Center	An investigation of several aspects of Landsat D data quality for the LIDQA program.
Albert Zobrist	NASA/Jet Propulsion Laboratory	Evaluation of Landsat D TM and MSS ground segment geometry performance without ground control.

SIMULATED TM DATA BEING STUDIED AT EDC

In anticipation of the availability of Landsat 4 TM data, numerous Government, academic, and private research organizations have been conducting studies of aircraft-acquired data from scanners which provided spectral and spatial resolution characteristics similar to those of the TM on Landsat 4. Most of these studies have been directed toward evaluating the additional benefits, in terms of specific problem-oriented applications, which can be expected from TM data. Notable success, for example, has been demonstrated in the area of improved lithologic discrimination, particularly in the identification of zones of hydrothermal alteration in sparsely vegetated areas. Such success is primarily a result of data acquired in the 2.10-to 2.34-μm region of the electromagnetic spectrum (which corresponds to TM band 7). Hydrous minerals, which are a dominant constituent of most hydrothermal alteration zones, exhibit strong absorption bands in this region and result in unique spectral signatures on images produced from data which include this portion of the spectrum.

Studies are currently being conducted at EDC to evaluate the capabilities of TM data in discriminating lithologic variations in sedimentary rocks and in detecting surficial effects related to subsurface hydrocarbon occurrences. TM Simulator (TMS) data have been acquired by NASA over selected areas in the Uinta and Piceance sedimentary basins of northeastern Utah and northwestern Colorado, and they are being studied along with high-spectral-resolution (up to 950 bands between 0.34 and 2.58 μm) ground and airborne spectroradiometric data collected from the same areas. The ground and airborne data are being used in the calibration of the TMS data as well as in designing optical digital image processing techniques to be applied to the TMS data. Although the work is not complete, initial results show that TMS data acquired over the Split Mountain anticline (east of Vernal, Utah) can be digitally processed to produce images which permit significantly better separation of sedimentary units than can be accomplished with images produced from Landsat MSS data.

NEW CCT FORMAT TO BE IMPLEMENTED

Concurrent with the launch of Landsat 4, EDC will begin offering computer-compatible tapes (CCT's) of Landsat MSS data in a new format. This format will conform to the guidelines recommended by the Tape Standards Committee of the Landsat Ground Station Operators Working Group, as announced in issue No. 21 of this newsletter last January.

The CCT format now being used will be retained for approximately 1 year after launch, meaning that two formats will be available for a period of time. The format now being used is referred to as the Landsat MSS VERSION 0. The new format is referred to as the Landsat MSS VERSION 1. Both the VERSION 0 and the VERSION 1 formats will be available for any Landsat MSS data acquired after January 1, 1979, until VERSION 0 is discontinued. At that time, VERSION 1 will be the only CCT data format available. The old "CCT-X" format will still be used for any data acquired before Jan. 1, 1979.

Documentation of the new Landsat MSS VERSION 1 format and sample CCT's (at a reduced price) can be obtained from EDC. Interested users should contact:

User Services Section
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198
telephone: (605) 594-6151

SYMPOSIA

A symposium entitled **Advances in Instrumentation of Processing and Analysis of Photogrammetric and Remote Sensing Data** will take place August 30 to September 3, 1982, in Ottawa, Canada. It is sponsored by Commission II of the International Society of Photogrammetry and Remote Sensing. A call for papers has been issued. For further information, contact Z. Jaksic, President, Commission II (ISPRS), Division of Physics, National Research Council of Canada, Bldg. M-36, Montreal Road, Ottawa, Ontario K1A 0R6, Canada, telephone: (613) 993-2074.

A **National Conference on Energy Resource Management** will be held September 9-12, 1982, in Baltimore, Md. This conference is being jointly sponsored by the American Planning Association's Energy Planning Division and the Eastern Regional Remote Sensing Application Center (ERRSAC) of NASA's Goddard Space Flight Center. The objective is to bring together professionals in the field of energy resource management, energy facility sitings, energy resource extraction, remote sensing, geographic information systems, and related disciplines from the United States and other countries. Participants will focus on the use of remote sensing in these disciplines. Information about the conference can be obtained from Yale M. Schiffman, The MITRE Corporation, 1820 Dolley Madison Blvd., McLean, VA 22101, telephone: (703) 827-7243.

The **International Society for Photogrammetry and Remote Sensing** will host a symposium in Toulouse, France, September 13-17, 1982. The symposium will present the activities of the Society's Commission VII working group relevant to two main subjects: (1) the methodologies for joint operational use of photogrammetry and remotely sensed data and (2) the use of a new generation of operational satellites that should be available in the 1980's. An international exhibition will be held concurrently with the symposium. For further information, contact:

Groupement pour le developement
de la Teledection Aerospatiale
18, avenue Edouard-Belin
31055 Toulouse Cedex, FRANCE
Tel: (61)53.11.12

A symposium entitled **Resources Survey for Land Use Planning and Environmental Conservation** will be held October 20-22, 1982, at the Indian Photo-Interpretation Institute, under the auspices of the Indian Society of Photo-Interpretation and Remote Sensing, Dehra Dun. The symposium will be co-sponsored by many national departments and institutes. All correspondence related to the symposium may be addressed to Prof. D. P. Rao, Organizing Secretary (ISPI&RS), Indian Photo-Interpretation Institute, 4 Kalidas Rd., Dehra Dun-248001, U.P. (INDIA).

SHORT COURSE ON NATURAL RESOURCE SURVEYING

The Cranfield Institute of Technology, in Bedford, England, has announced plans to repeat a 5-day short course it held last January on the subject of "Remote Sensing for Natural Resource Surveying." The course was run by the Faculty of Agricultural Engineering, Food Production, and Rural Land Use, and it consisted of an intensive lecture program combined with case studies and practical exercises stressing remote sensing applications and computer-aided image analysis.

Those who are interested in attending such a short course in the near future are invited to contact Dr. J. C. Taylor, c/o The Short Course Secretary, National College of Agricultural Engineering, Silsoe, Bedford, MK45 4DT, United Kingdom.

PUBLICATIONS

The University of Rhode Island's Marine Advisory Service has announced a new reference manual entitled **A Guide to Environmental Satellite Data.** The document is designed particularly for scientists wishing to use satellite remote sensing as a tool for studying the coastal and ocean environment, but its use would not be restricted to this purpose. The 469-page volume is priced at $20. Inquiries should be made to the University of Rhode Island, Marine Advisory Service, Publications Unit, Naragansett Bay Campus, Naragansett, RI 02882.

SELF-INSTRUCTIONAL MODULES IN REMOTE SENSING

Purdue University has announced the release of six self-instructional, audiovisual modules dealing with remote sensing topics. Each module, or "mini-course," consists of 35-mm color slides, an audio tape, a printed study guide, and in many cases additional maps and photographs. The instructional level is appropriate for both professional training and university courses. Produced by the Laboratory for Applications of Remote Sensing (LARS) at Purdue, these new modules augment a collection of 19 units released previously as part of the LARS **Fundamentals of Remote Sensing** series. The newly released titles are as follows:

- "Principles of Photointerpretation"
- "Interpretation of Thermal Energy"
- "Mineral Exploration Using Satellite Data"
- "Selecting Landsat Imagery"
- "Photogeology"
- "Spectral Measurements for Field Research"

For further information about these and other remote sensing instructional materials available from Purdue, contact Gerald W. O'Brien, Director, Division of Independent Study, 116 Stewart Center, Purdue University, West Lafayette, IN 47907, telephone: (317) 494-7231.

STATUS OF GSFC DIGITAL PROCESSING

The backlog of Landsat digital processing at GSFC, which has been tracked in the chart below for the last several issues, has recently been eliminated. As shown by the shaded areas in the chart, all processable Landsat MSS and RBV data acquired through July 1, 1982, have been processed and sent to EDC.

LANDSAT DIGITAL PROCESSING STATUS AT GSFC
(RADIOMETRICALLY CORRECTED DATA ONLY)

	MSS				RBV			
	'79	'80	'81	'82	'79	'80	'81	'82
January					N/A	N/A		
February					N/A	N/A		
March					N/A	N/A		
April					N/A	N/A		
May					N/A	N/A		
June					N/A	N/A		
July					N/A	N/A		
August					N/A	N/A		
September					N/A			
October					N/A			
November					N/A			
December					N/A			

NA = Prior to digital operations, no backlog incurred.
= Digital processing backlog closed out, all scenes at EDC

NOAA'S MANAGEMENT OF THE OPERATIONAL LANDSAT SYSTEM

[The following remarks were contributed by NOAA's National Earth Satellite Service]

NOAA's National Earth Satellite Service (NESS) has managed this nation's operational weather monitoring satellite programs since the beginning of this activity in the early 1960's. Through the years, this agency has maintained reliable operational polar-orbiting and geostationary satellite systems which provide, along with more obvious weather and ocean services:

- Information needed to track severe storms and hurricanes more closely.
- Measurements of the temperature and wind at various levels of the atmosphere for use in weather forecasting.
- Locations of ocean temperature fronts, significant in efficient maritime navigation as well as locating commercial quantities of fish.
- Estimates of the amount of rainfall in potential flash flood situations.

All such services must be provided under tight timelines, 24 hours a day, every day of the year, and NOAA/NESS has consistently met this challenge.

These NOAA operational characteristics, and its experience, organization, approach, and performance, influenced the decision to implement the operational Landsat program under NOAA management. In fact, experience was cited in the announcement that assigned Landsat to NOAA in 1979.

Duplicating this success in its Landsat activities is the NOAA goal. NOAA has a Landsat management team in place and preparations for taking over the operation, after the system is checked out, are well underway.

NOAA will be the single manager of the operational Landsat program, responsible for spacecraft scheduling, ground processing and production, and customer services. Single agency management will assure customers of a single point of contact for all Landsat services and will allow NOAA to fit the system's pieces—satellites, ground facilities, communications, and people—to the single purpose of supporting customers.

Customer service and efficient production are the cornerstones of the NOAA operation. When NOAA was assigned the Landsat operational system in November 1979, it began a program to inform and gain feedback from interested individuals and organizations. This contact continues today with a series of meetings scheduled throughout the country in May and June to solicit views from the user community concerning the makeup of the routine collection of data from Landsat. This routine collection program has been called the Basic Data Set (the subject of an article elsewhere in this issue).

Single-agency management of the Landsat operation will allow NOAA to achieve efficiency in production. NOAA plans to have all requests for Landsat data forwarded to EDC. There, these requests will be divided into retrospective and special acquisitions. Retrospective requests will be

filled directly from the archive; special acquisitions will be forwarded to the spacecraft command and scheduling activity at Goddard for spacecraft scheduling. Each order will be tracked from beginning to end in a special data base that will have the up-to-the-minute status of each order.

As the single manager of the total system, NOAA will be in a position to plan and control the production of Landsat products in the most efficient manner. This is all the more important today as the cost of the operation must be recovered through fees charged to users.

With the cooperation of the customer community and NOAA's two decades' experience in operational production, the Landsat program will deliver cost-effective solutions to the problem of Earth resources monitoring.

EDC COURSE ANNOUNCEMENT

The EROS Data Center will be offering a training course entitled **The Role of Remote Sensing in a Geographic Information System** from December 6-10, 1982. This specialized course will emphasize the contributions of remotely sensed and other kinds of spatial data (including terrain models) to geographic information systems, as well as the types of spatial analyses commonly used for natural resource applications. The course is designed for remote sensing analysts and resource specialists and assumes an understanding of the fundamentals of remote sensing. For more information, contact the Chief, Training and Assistance, Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198.

REMOTE SENSING TRAINING

Aug. 2-5 **Remote Sensing and Digital Image Processing** (San Francisco, Calif.) Contact: Dr. Ed Winter, Technical Research Associates, 350 N. Lantana, Suite 661, Camarillo, CA 93010, telephone: (805) 987-1972.

Sept. 13-17 **Applying Remote Sensing Techniques to the Marine Environment** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington University, Washington, D.C. 20052, telephone: (202) 676-6106.

Oct. 4-8 **The Application and Processing of Landsat Data** (Murray, Ky.) Contact: Dr. Neil V. Weber, Director, Mid-America Remote Sensing Center, Murray State University, Murray, KY 42071, telephone: (502) 762-2148.

Oct. 18-22 **Remote Sensing for Global Resource Applications** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington Univeristy, Washington, D.C. 20052, telephone: (202) 676-6106.

Oct. 25-29 **Digital Image Processing of Earth Observation Sensor Data** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington University, Washington, D.C. 20052, telephone: (202) 676-6106.

EDC LANDSAT PRODUCTION STATISTICS

	Dec. '81		Jan. '82		Feb. '82		Mar. '82		Apr. '82		May '82		6-Month Total	
	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV	MSS	RBV
Landsat scenes acquired (satellite acquisitions)*	1,484	411	1,191	408	839	260	1,263	465	2,504	628	2,158	544	9,419	2,712
Landsat MSS scenes/RBV subscenes received at EDC	2,464	2,735	1,500	3,650	1,147	3,362	945	3,222	1,847	1,744	1,562	1,711	9,465	16,424
Average time in days from EDC receipt to archive availability	22.8	14.0	31.1	9.6	9.7	15.4	4.3	5.9	9.7	6.9	8.0	8.6	–	–
Average delivery time in days from receipt of order at EDC to shipment:														
Standard photographic products	20		17		9		10		13		13		–	
Standard digital products	14		9		6		6		12		7		–	
Landsat photographic frames sold	8,258		7,117		8,078		5,860		9,076		7,385		45,774	
Landsat digital scenes sold	351		208		263		280		181		497		1,780	
TOTAL LANDSAT DOLLAR VOLUME	$221,788		$182,828		$224,076		$185,240		$213,641		$262,242		$1,289,815	

*Figures are revised periodically to reflect updated information received from NASA.

EDC TRAINING SCHEDULE

Aug. 30-Oct. 1 **International Remote Sensing Workshop: Applications in Vegetation Assessment and Land Use Planning** (Sioux Falls, S. Dak.) Open to non-U.S. scientists. Contact: Office of International Geology, U.S. Geological Survey, National Center, Mail Stop 917, Reston, VA 22092, telephone: (703) 860-6418.

Sept. 13-17 **Introduction to Remote Sensing for Land Cover Mapping** (Anchorage, Alaska) Open enrollment. Contact: Chief, USGS/EROS Field Office, 218 'E' Street, Anchorage, AK 99501. telephone: (907) 271-4065.

Oct. 25-29 **Terrain Analysis: Interpretation of Aerial Photographs and Images** (Sioux Falls, S. Dak.) Contact: Coordinator, Continuing Education Program, Harvard Graduate School of Design, Gund Hall, L-37, Harvard University, Cambridge, MA 02138, telephone: (617) 495-2578.

Nov. 1-5 **Hydrology Information Workshop** (Sioux Falls, S. Dak.) Open enrollment. Contact: Chief, Training and Assistance, Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

Nov. 15-19 **Advanced Geological Workshop** (Sioux Falls, S. Dak.) Open enrollment. Contact: Chief, Training and Assistance, Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

Dec. 6-10 **Role of Remote Sensing in a Geographic Information System** (Sioux Falls, S. Dak.) Open enrollment. Contact: Chief, Training and Assistance, Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

The Landsat Data Users NOTES is published bimonthly in order to present information of interest to the user community regarding Landsat products, systems, and related remote sensing developments. There is no subscription charge; individuals and organizations wishing to receive the NOTES should contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, U.S.A., telephone: (605)594-6151.

Comments, corrections, and other inquiries should be directed to:

Editor, Landsat NOTES
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198

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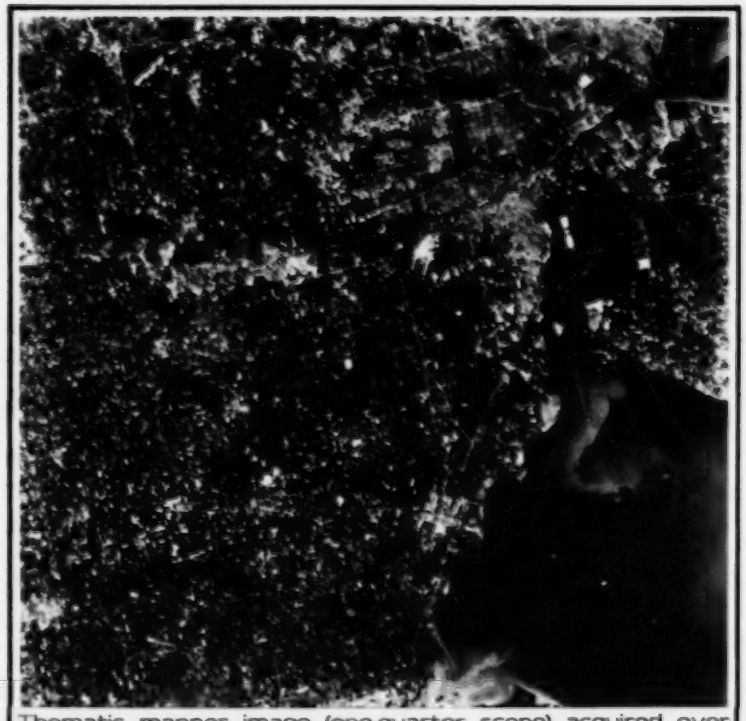
THEMATIC MAPPER "PREVIEW" SCENES AVAILABLE

The Earth Resources Observation Systems Data Center (EDC) has received a limited amount of thematic mapper (TM) that were acquired very soon after the launch of Landsat 4. Released by the National Aeronautics and Space Administration (NASA) to provide users a preview of the kind of data that are being acquired by the TM, these products are available in the form of false-color composite images generated from bands 2, 3, and 4; natural-color composite images generated from bands 1, 2, and 3; or single-band, black-and-white images of data from band 3 and certain other bands. One computer-compatible tape (CCT) containing four bands (1, 2, 3, and 4) of image data in digital form is also available. These first data from the TM sensor were acquired over the following areas:

- Detroit, Mich., and vicinity—data acquired on July 20, 1982, 4 days after launch, and July 25, 1982, 9 days after launch, are available. The July 25 scene is also available in digital form on a CCT. A band 3 black-and-white image generated from the data acquired on July 20 is shown below.
- Rathbun Dam, Iowa, and vicinity—consists of a partial scene acquired on July 21, 1982, 5 days after launch.
- Baltimore, Md., and vicinity—consists of a partial scene acquired on July 29, 1982, 13 days after launch.

Users should contact EDC for specific information on the types of products that are currently available from each of the above.

These data are considered engineering products and were produced in conjunction with post-launch testing conducted by



Thematic mapper image (one-quarter scene) acquired over Detroit, Mich., and vicinity shortly after launch of Landsat 4. Shown is band 3, sensed in the 0.63- to 0.69-μm region of the spectrum.

Landsat Data Users NOTES

ISSUE NO. 24
SEPTEMBER 1982

NASA

U.S. GEOLOGICAL SURVEY
EROS DATA CENTER
Sioux Falls, S. Dak. 57198

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NASA. Photographic film or paper prints in 9.5-inch (241 mm) format, or enlargements on paper only, are available as standard products and may be ordered by contacting:

Landsat Customer Services
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594 6151

The image shown on the cover is a band 3, one-quarter scene generated from the data acquired over Detroit, Mich., and vicinity on July 20, 1982. Detroit, Mich., and Windsor, Ontario, are on the shores of Lake St. Clair in the upper right portion of the image. Most of the lower right quadrant of the image is taken up by the west end of Lake Erie.

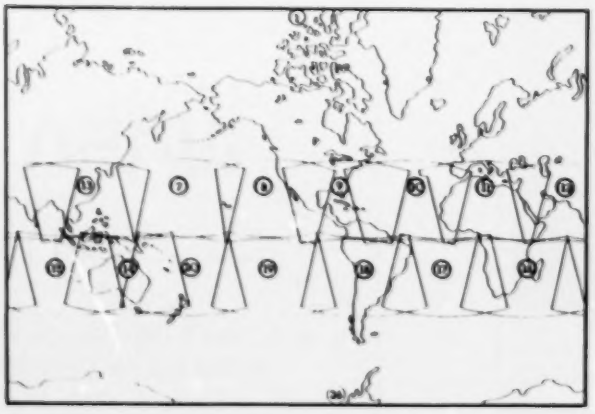
LANDSAT 4 WRS INDEX MAPS EXPECTED SOON

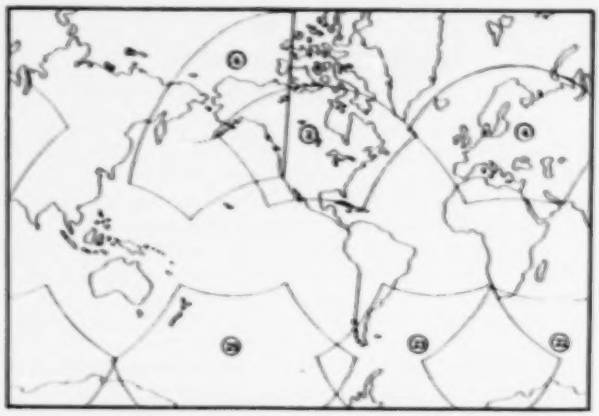
A series of 26 maps depicting the locations of Landsat 4 Worldwide Reference System (WRS) nominal scene centers on every part of the globe will soon be completed. The first 13 of these maps, covering most of the land masses of the world, will be available toward the latter part of this year. The remaining 13 will follow in the first quarter of 1983.

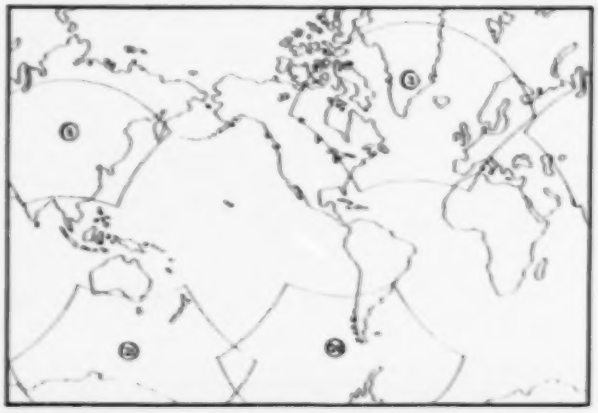
Referring to WRS nominal scene centers is the easiest way for many users to designate a geographic area of interest when ordering Landsat data. The Landsat 4 WRS indexing scheme defines a global network of 233 paths (one for each ground track) and 248 rows (corresponding to lines of latitude). The path and row intersections correspond to the geographic locations over which repetitive Landsat scenes are generally centered.

When reference is made to one of these path-row intersections by identifying a 3-digit path number and a 3-digit row number, all Landsat 4 scenes imaged over that point are immediately identified.

New index maps showing WRS path-row locations were necessary because Landsat 4's orbit traverses 233 paths as opposed to 251 paths for Landsats 1 through 3.







The new map sheets are 1:10,000,000-scale, navigation-type charts on which the path-row information is overprinted. Some relief, drainage, and transportation detail are shown on the land masses, and political boundaries are marked. The reverse side of each map provides a WRS path-row index of the same area for Landsats 1 through 3.

The 26 map sheets are numbered as shown below. The sheet numbers also appear on the three sheet indexes (maps themselves) which accompany this article. The sheet indexes give an indication of the geographic extent of each of the WRS Index Maps listed below.

Sheet No.	Publication Date
1	Early 1983
2	Late 1982
3	Late 1982
4	Late 1982
5	Late 1982
6	Late 1982
7	Early 1983
8	Early 1983
9	Late 1982
10	Early 1983
11	Late 1982
12	Late 1982
13	Late 1982
14	Late 1982
15	Early 1983

16	Late 1982
17	Early 1983
18	Late 1982
19	Early 1983
20	Early 1983
21	Early 1983
22	Early 1983
23	Early 1983
24	Late 1982
25	Early 1983
26	Early 1983

Any of the above, once published, may be obtained free of charge (limit of two per requester) from one of the following:

Distribution Branch
U.S. Geological Survey
Box 25286
Federal Center
Denver, CO 80225
Telephone: (303) 234-3832

Landsat Customer Services
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594-6151

EDC NOW HANDLING MSS ACQUISITION REQUESTS

Concurrent with the launch of Landsat 4 on July 16, 1982, EDC began accepting user requests for special acquisitions by the MSS sensor carried aboard. This request system is provided for those users who have specific requirements for data that may not be obtained through routine acquisition scheduling. Beginning October 1, 1982, requesters will pay a special acquisition fee for data received in return for assurance that the coverage they specify will be obtained.

Several coverage parameters, or scene characteristics, may be specified by the user when making such a request. These include:

- Geographic area of interest.
- Data of coverage.
- Maximum acceptable cloud cover (minimum of 30 percent).
- Data compression mode (linear or compressed).
- Sensor gain (high or low).

Once the acquisition criteria are specified, EDC coordinates the request with others that have been received and forwards a weekly list of scene requirements to NASA's Goddard Space Flight Center. Goddard schedules the acquisitions, transmits commands to the spacecraft, and, if at all possible, the scenes are acquired. EDC handles all associated billing and accounting functions and serves as the customer's point of contact until the requested images are eventually received. Processing and distribution of products take place in the same fashion as with any other Landsat data.

Effective October 1, 1982, the price structure set forth in the table below will apply to these user-specified MSS acquisitions. Prices are determined by the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), which will assume managerial responsibility for Landsat product generation and distribution on that date. The prices below were established by NOAA.

SPECIAL ACQUISITION PRODUCT PRICES

(Special acquisitions are Landsat 4 MSS scene data that are not scheduled for routine collection, but which are provided upon user request.)

Product	Price
Delivery of preprocessed digital data to the requester's site via communication satellite; per MSS scene collected at a time and place specified by the requester	$ 790
Delivery to the requester of a frame of standard black-and-white MSS imagery in four spectral bands; per MSS scene collected at a time and place specified by the requester	$ 880
Delivery to the requester of a CCT or high-density digital tape (HDT); per MSS scene collected at a time and place specified by the requester	$1000
Surcharge for delivery of a color composite to the user originally requesting the special acquisition of an MSS scene; per scene	$ 150
Surcharge applied when the requester establishes a maximum allowable cloud cover condition for the collection of an MSS scene; per scene	$ 250

Prospective requesters in need of further information are invited to contact: Landsat Customer Services, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6151.

LANDSAT 4 MSS COMPUTER-COMPATIBLE TAPES

Users of Landsat 4 MSS computer-compatible tapes (CCT's) should be aware of some differences between these tapes and those produced from MSS data acquired by previous Landsats.

As pointed out in the last issue of the NOTES (No. 23, p. 13), Landsat 4 CCT's will be offered in two formats. One of these is a new format tailored to the specifications of an international standard defined by the Landsat Ground Station Operators Working Group. Referred to as VERSION 1, this format is being offered beginning with the availability of Landsat 4 MSS data and has been described in a separate format document.

A second format, used previously for Landsat 2 and 3 CCT's and referred to as the VERSION 0 format, is also being offered. This format has had to be modified slightly to accommodate the MSS data now being acquired by Landsat 4. These modifica-

tions have not been separately described for the user. The changes affect certain fields having to do with the numbering of MSS spectral bands, the inclusion of supplementary or new information related to the radiometric and geometric corrections performed at Goddard, the quality coding of the MSS image data to be found on the tape, and other areas where differences between Landsat 4 and previous missions have required modification of the VERSION 0 format.

Documentation of the VERSION 0 format changes is provided in a special supplement to the "Manual on Characteristics of Landsat Computer-Compatible Tapes Produced by the EROS Data Center Digital Image Processing System," dated December 1978. The supplemental tables that have recently been issued as an addendum to this manual describe the Landsat 4-related changes in full.

Users interested in obtaining this documentation should contact the EROS Data Center at the address given below. There will be no charge.

Landsat Customer Services
EROS Data Center
Sioux Falls, SD 57198
Telephone: (605) 594-6151

INTERNATIONAL LAND SATELLITE PROGRAMS

Landsat 4 is one of several Earth resources satellites that will be operating in the 1980's. Other nations have, or plan to launch in the near future, remote sensing systems of their own. Some of these programs are described below.

France

The Centre National d'Etudes Spatiales in France is developing an Earth resources satellite known as the Systeme Probatoire d'Observation de la Terre (SPOT). This spacecraft is planned for launch in 1984 by the French-developed Ariane expendable launch vehicle. Mission control and data processing will be at Toulouse, France. The payload will consist of two high-resolution visible (HRV) imaging instruments employing multilinear array technology. An onboard tape recording capability will be provided.

The HRV instruments are designed to operate in either a black-and-white panchromatic mode or a multispectral mode, operating, respectively, with a 10-meter or a 20-meter instantaneous field of view. In the panchromatic mode, data will be acquired in the 0.51- to 0.73-μm band of the spectrum. The multispectral mode will provide data in three discrete spectral bands: 0.50 to 0.59 μm (green), 0.61 to 0.68 μm (red), and 0.79 to 0.89 μm (reflected infrared). The multilinear array sensors of the HRV instrument will sample some 6,000 individual detectors to produce the very-high-resolution fields of view that are planned.

SPOT will be launched into a near-polar, Sun-synchronous orbit at a nominal altitude of 822 km, inclined 98.7° to the equatorial plane. The satellite's orbital repeat period will be 26 days.

A rotating mirror in the SPOT sensor package will permit a given scene of the Earth to be acquired from areas up to 400 km left or right of the spacecraft, in addition to the normal vertical vantage point (from which a 117-km swath will typically be imaged). This "off-nadir" viewing, or pointing capability, has two distinct advantages. First, more frequent looks at high-priority scenes will be possible. Second, the capability for recording stereoscopic pairs of images for a given scene is provided. Stereoscopic capability will permit photogrammetric applications of the data.

A SPOT-2 mission is planned to follow SPOT-1. A series of SPOT satellites thereafter is expected to provide data continuity into the 1990's.

Japan

The Japanese plan to launch their first Earth resources satellite in 1986. Known as the Marine Observation Satellite-1 (MOS-1), this platform is expected to provide data which will help develop fundamental technologies common to both marine and land observation satellites. MOS-1 will be launched by the Japanese H-1 launching vehicle from Tanegashima Space Center. It will assume a Sun-synchronous orbit at an altitude of 913 km and will have an orbital repeat period of 14 days.

The satellite will carry three sensor systems designed to measure sea-surface color, sea-surface temperature, and water content of the atmosphere. The first sensor will be a multispectral, electronic, self-scanning radiometer (MESSR) which will collect data in four bands in the visible and near-infrared portions of the spectrum, as follows: 0.51 to 0.59 μm, 0.64 to 0.72 μm, 0.72 to 0.80 μm, and 0.80 to 1.1 μm. The instantaneous field of view will be 50 m by 50 m. The sensor will be of the multilinear array type similar to that of the French SPOT system and will consist of 2,048 detector elements. The ground swath imaged will be approximately 200 km wide.

The second sensor will be a visible and thermal-infrared radiometer (VTIR). The VTIR will collect sea-surface temperature data in four spectral bands: 0.5 to 0.7 μm, 6 to 7 μm, 10.5 to 11.5 μm, and 11.5 to 12.5 μm. The instantaneous field of view will be 90 m by 90 m for the first band and 2,700 m by 2,700 m for the remaining three bands, with a maximum ground swath width of 1,500 km. The VTIR will be a mechanical scanner (as opposed to the push-broom type of scanning employed by the MESSR) and will measure cloud cover and other such features in addition to sea-surface temperature.

The third sensor on MOS-1 will be a microwave scanning radiometer (MSR) which will operate in the 23.8 GHz and 31 GHz ranges with an instantaneous field of view of 40 km and 30 km, respectively. It will measure the content of water vapor in the atmosphere, as well as snow, ice, and sea-surface condition.

The Japanese have also conducted preliminary studies for a Land Observation Satellite (LOS) with a sensor complement designed primarily for land use classification and vegetation analysis. This concept was recently combined with one resulting from a separate effort to design a sensor payload for geologic exploration. The two objectives are to be met by a single Earth Resources Satellite

(ERS-1). ERS-1 will carry a linear array stereoscopic camera with a 30-m instantaneous field of view in four spectral bands between 0.51 and 1.10 μm, and an L-band synthetic aperture radar providing 25-m ground resolution for a 75-km swath. The launch of ERS-1 is planned for sometime in 1989.

European Space Agency

The European Space Agency (ESA) is committed to the development and launch of a European remote sensing satellite. The original proposal was to orbit two Earth observation satellites, one for coastal zone and ocean monitoring and the other for land applications. However, these concepts were later combined into a single spacecraft called the ESA Resource Satellite-1 (ERS-1).[1] ERS-1 will be designed principally for ocean observations. It is planned for launch in 1987 and will be placed into a 650-km, near-polar, Sun-synchronous orbit. The sensor package will consist of:

- A synthetic aperture radar, which will provide 30-m resolution for a 100-km ground swath.
- An ocean color monitor, which will sense data in 10 spectral bands between 0.4 and 11.5 μm.
- An imaging microwave radiometer, operating in six different frequencies.
- A two-frequency scatterometer, for sensing wind direction and velocity.
- A radar altimeter, which will be used for sea state determination.

ERS-1 data transmissions will be handled through ESA's Earthnet receiving station network.

A second-generation spacecraft, the Advanced ESA Resource Satellite (AERS), designed principally for land observations, has also been proposed. It would carry a synthetic aperture radar similar to that on ERS-1, and some other instruments.

A joint venture between ESA and NASA is a payload, called "Spacelab," to be carried aboard the U.S. Space Shuttle. Currently scheduled for launch in September 1983, Spacelab will consist of both manned experimental modules and pallets for other instruments. An ESA-built metric camera experiment, consisting of a standard Zeiss 30/23 aerial camera with a 30-cm focal length and a 23-by 23-cm image format size, will be operated through a window in the manned module. From the anticipated 250-km altitude, these pictures will cover an area of 190 by 190 km on the ground and will have a resolution of approximately 20 m. The metric camera experiment represents only the first phase of a development program that is eventually expected to result in a manned-module camera system with image motion compensation, a longer focal length, and much better resolution.

Spacelab will also include a microwave remote sensing experiment. The instrument will operate as a two-frequency scatterometer to measure ocean wave spectra, as a passive thermal radiometer to measure surface temperature (sensitivity of ± 1 K), or as a synthetic aperture radar providing 25-m resolution over a 9-km swath.

Subsequent Spacelab missions are planned with various objectives such as life science and materials processing. One of these missions has been designated for Earth and atmospheric observations, and a tentative selection of instruments has been proposed. The Earth observation instruments on this Spacelab mission would include the metric camera and microwave remote sensing experiments from Spacelab 1, a multispectral linear array camera operating in the visible wavelengths, an optical-mechanical scanner operating in the near and thermal infrared wavelengths, and a synthetic aperture radar. Launch is currently planned for 1984-85.

U.S.S.R.

The Russian manned spacecraft, Salyut 6, has carried several film camera systems for Earth observation since being placed in orbit in 1977. One is the MKF-6M system,[2] which comprises six separate cameras with dielectric filters to produce multispectral photographs in the range of 0.45 to 0.94 μm. Each camera has a focal length of 125 mm and is capable of producing images with ground resolution in the 15- to 20-m range. A rocking mount is provided for image motion compensation. A second camera system is a Zeiss MRB-9/2323 wide-angle aerial survey camera. It has a focal length of 90 mm and a film format size of 23 by 23 cm. A third camera system aboard Salyut 6 is the KATE-140 mapping camera. Having a focal length of 140 mm, the KATE-140 is probably capable of producing a ground resolution of about 30 m from an altitude of 260 km (the initial Salyut 6 altitude). Each frame would cover an area of about 335 by 335 km.

Certain missions in the Russian Cosmos series have also been designated as Earth resource observation spacecraft. Typically, they are launched into low (220-270 km), near-polar (81°-82° inclination) orbits and are recovered after 15-30 days of operation. Most probably, the primary sensor system used aboard these craft has been an MKF-6 camera system.

In June 1980, the U.S.S.R. launched one of its "Meteor" weather satellites into a 635-km orbit at 98° inclination. An article on this mission can be found in the January 1982 issue of this newsletter (No. 21). Meteor carries three experimental Earth observation sensors. One, the MSU-E, is a solid-state scanner sensing three spectral bands between 0.5 and 1.0 μm and providing a 30-m instantaneous field of view. The other two, the MSU-SK and the "Fragment," are optical-mechanical scanner systems. The MSU-SK senses four spectral bands between 0.5 and 1.0 μm (170-m instantaneous field of view). Fragment gathers data in eight bands between 0.4 and 2.4 μm (80-m instantaneous field of view). The Meteor mission is part of an experimental effort by the U.S.S.R. to develop an operational method for the study of Earth rsources from space.

In general, very few data from any of Russian Earth resources missions have been made available to the international community.

[1] By coincidence, both the Japanese and the ESA Satellites are designated by the same acronym: ERS-1

[2] The designation MKF-6M and some other acronyms used in this article have no known definitions and should be interpreted only as unique mnemonics designating a certain equipment type.

The People's Republic of China

The People's Republic of China has launched several satellites with Earth observation payloads, beginning with Chinasat-1 in July 1975. These satellites were placed in elliptical orbits (perigees ranging from 167 to 185 km, apogees from 464 to 489 km) at relatively low angles of inclination (59°-69°). Images from these missions have not been available to the international community.

Future Earth observation missions planned by The People's Republic of China include Chinasat-10, to be launched within the next year or two and to carry a two-channel, visible and infrared band, meteorological radiometer. Another observatory, Chinasat-12, is proposed for launch into a 700-km polar orbit in 1985. This spacecraft will carry an Earth resources sensor with an 80-m instantaneous field of view. China also recently announced plans to proceed with the development of its own 11-band multispectral scanner, linear array sensor, and synthetic aperture radar.

India

The Indian Space Research Organization has been gathering Earth resources satellite data since launch of the Bhaskara-1 satellite in June 1979. Bhaskara-1 carried two television cameras providing 1-km resolution in two spectral bands for land observation. Also aboard were three microwave radiometers for ocean survey purposes. An identical spacecraft, Bhaskara-2, was launched into the same 550-km-high, 51°-inclination orbit in November 1981. The Indians have announced their intention of develop a second-generation resources satellite, as well.

The Netherlands

The Netherlands Agency for Aerospace Programs has initiated study of a remote sensing satellite which would carry a Dutch-built multispectral linear array sensor in a near-equatorial orbit. This project is being planned in cooperation with Indonesia, where the ground data reception station will be located. The sensor parameters will be specifically selected for the weather conditions and vegetation types in the equatorial regions of the Earth.

Canada

The Canada Centre for Remote Sensing (CCRS) has completed a study aimed at determining the applicability of NASA Seasat data for monitoring ice conditions in the polar seas. The study concludes that a desirable sensor device would use a synthetic aperture radar capable of producing 25- to 30-m resolution for a swath width of approximately 100 km. Beginning in 1980, CCRS undertook a 2-year program to develop the operational parameters for a C-band radar which would meet these requirements. Sensor and orbit parameters, as well as ground processing capabilities, are also being studied. The eventual program might entail two or three satellites in orbit simultaneously to provide the necessary coverage for adequate monitoring of the arctic seas and coastlines.

Brazil

The Space Research Institute of Brazil has announced its intention to develop a national remote sensing satellite which may be launched as early as 1985 or 1986. The sensors would include a multispectral linear array and a high-resolution panchromatic camera, but few details have been released.

HCMM DATA PROCESSING COMPLETED

Digital reduction of remote sensing data acquired by the Heat Capacity Mapping Mission (HCMM), an experimental remote sensing satellite launched by NASA in 1978, will be officially terminated on September 30, 1982. HCMM performed diurnal thermal infrared surveys over the United States and other areas from April 26, 1978, to September 30, 1980. From the 26,500 frames of imagery that were collected, about 38,000 standard image products and 1,400 scenes in CCT form have been archived by the National Space Science Data Center (NSSDC) in Greenbelt, Md.

Large parts of North America, Europe, and Australia were imaged by HCMM. The accompanying maps give an approximate idea of those areas for which CCT's have been produced for both nighttime and daytime passes. A complete inventory of all HCMM data, digital and otherwise, is contained in the following three catalogs which are available free of charge from NSSDC.

Image Microfiche Catalog

A complete listing of all usable imagery is contained in a 493-page catalog that has been reproduced on microfiche. The scenes are listed by geographic coordinates. For each entry an order identification number is given together with an indication of the scene's cloud cover and processing quality. The products referenced include day-visible, day-infrared, and night-infrared images available in the form of 241-mm black-and-white transparencies or paper prints. Coverage was obtained over the contiguous United States, Alaska, southern and western Canada, Mexico, western Europe, northwest Africa, and eastern Australia. Delivery schedules require 4 weeks for processing after receipt of an order by NSSDC. Prices are described in the "HCMM User's Guide," also available from NSSDC.

Magnetic Tape Catalog

Some 1,400 standard image scenes on 9-track, 800- or 1600-bpi CCT's are listed in the 14-page "Magnetic Tape Catalog." These CCT's have been previously ordered by HCMM users and principal investigators. They contain some of the best HCMM data available. The approximate coverage areas represented on these digital tapes are shown on the maps that appear with this article.

Day/Night Registered Pairs Catalog

Approximately 115 registered day/night data sets, in both digital and photographic form, are available. Each registered data set consists of five images which include synoptic day-visible and day-infrared, rotated night-infrared, temperature difference, and thermal inertia data. The same set of five images is available in digital format on a three-reel CCT.

Data products, copies of these catalogs, and the

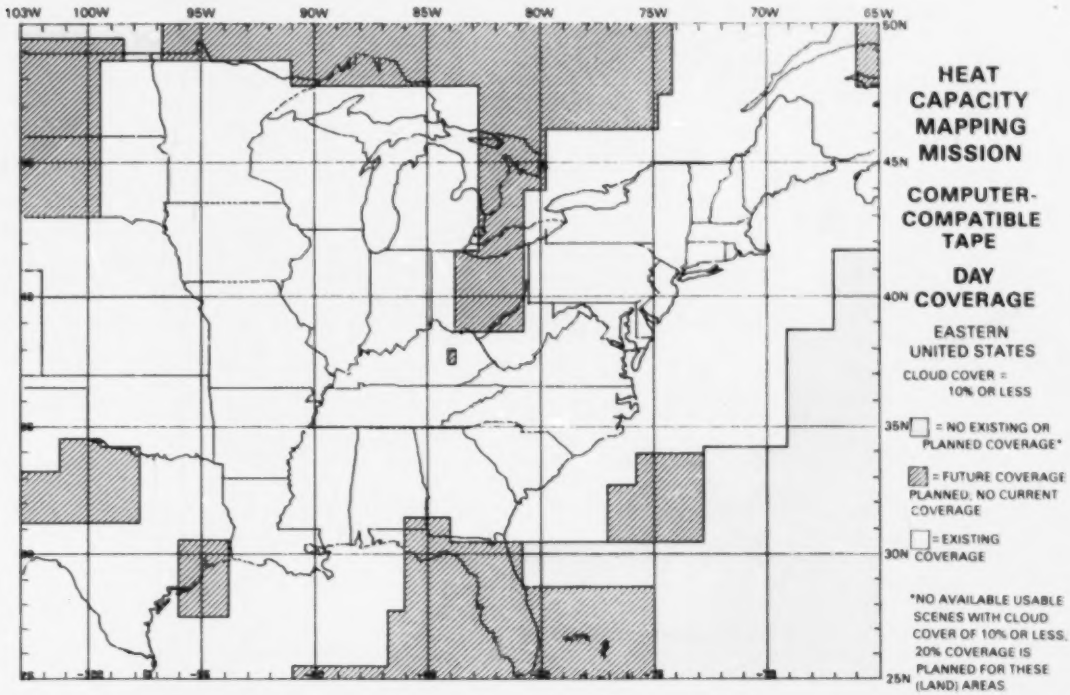
HCMM User's Guide are all available from one of the following:

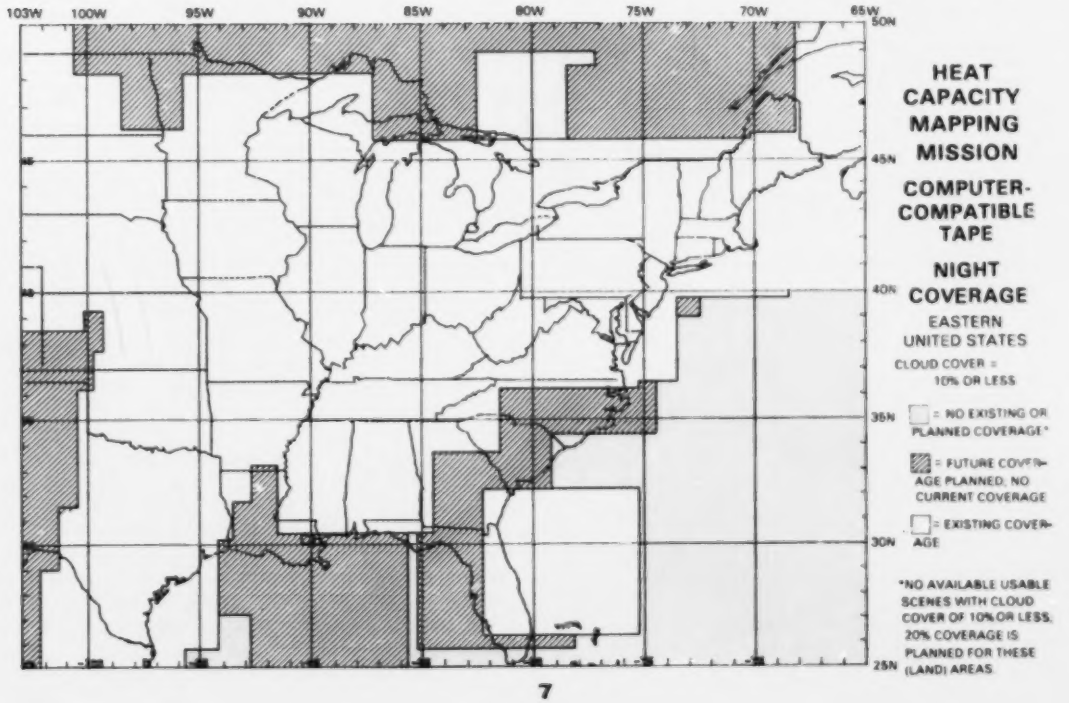
Domestic orders:

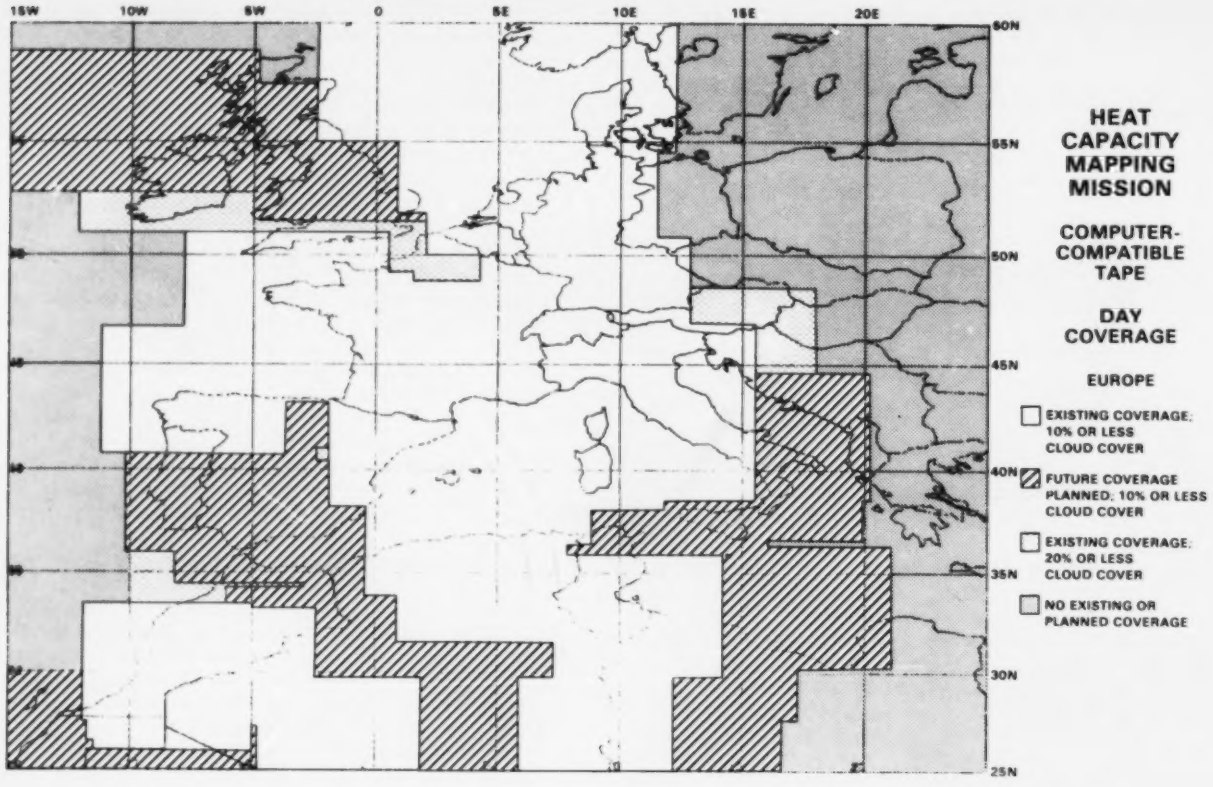
National Space Science Data Center (NSSDC)
Code 601
NASA/Goddard Space Flight Center
Greenbelt, MD 20771
Telephone: (301) 344-6695

Foreign orders:

World Data Center A for Rockets and Satellites
Code 601
NASA/Goddard Space Flight Center
Greenbelt, MD 20771, U.S.A.
Telex: 89675 NASCOM GBLT



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HEAT CAPACITY MAPPING MISSION
COMPUTER-COMPATIBLE TAPE
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EUROPE
EXISTING COVERAGE; 10% OR LESS CLOUD COVER
FUTURE COVERAGE PLANNED; 10% OR LESS CLOUD COVER
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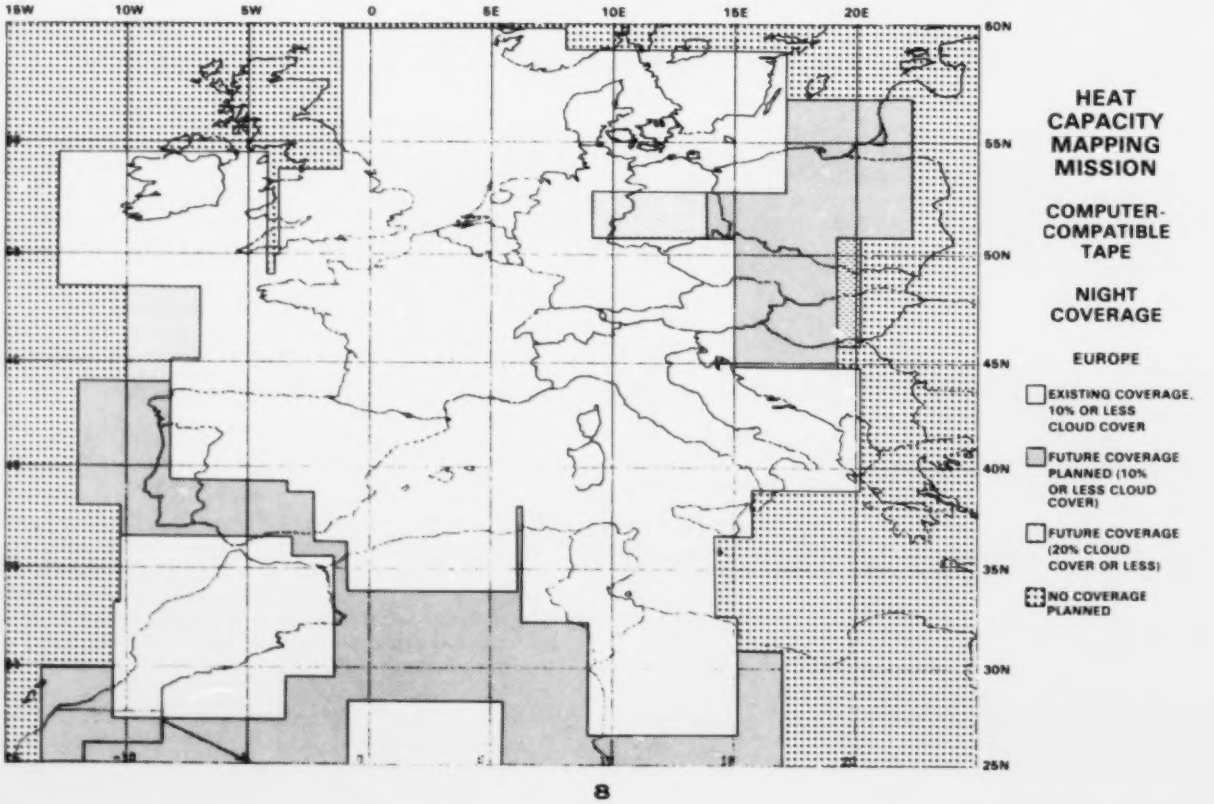
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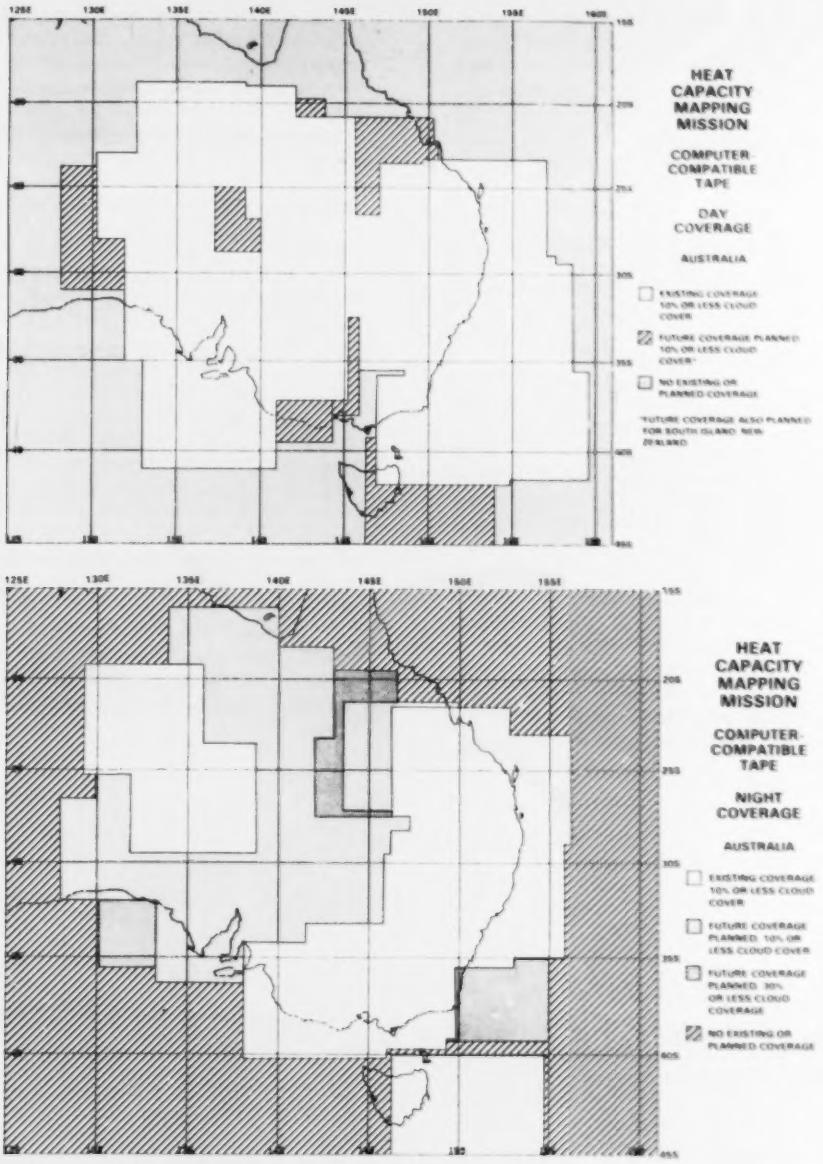
HEAT CAPACITY MAPPING MISSION
COMPUTER-COMPATIBLE TAPE
NIGHT COVERAGE
EUROPE
EXISTING COVERAGE, 10% OR LESS CLOUD COVER
FUTURE COVERAGE PLANNED (10% OR LESS CLOUD COVER)
FUTURE COVERAGE (20% CLOUD COVER OR LESS)
NO COVERAGE PLANNED


HEAT CAPACITY MAPPING MISSION
COMPUTER-COMPATIBLE TAPE
DAY COVERAGE
AUSTRALIA
EXISTING COVERAGE 10% OR LESS CLOUD COVER
FUTURE COVERAGE PLANNED 10% OR LESS CLOUD COVER*
NO EXISTING OR PLANNED COVERAGE
*FUTURE COVERAGE ALSO PLANNED FOR SOUTH ISLAND, NEW ZEALAND
HEAT CAPACITY MAPPING MISSION
COMPUTER-COMPATIBLE TAPE
NIGHT COVERAGE
AUSTRALIA
EXISTING COVERAGE 10% OR LESS CLOUD COVER
FUTURE COVERAGE PLANNED, 10% OR LESS CLOUD COVER
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NO EXISTING OR PLANNED COVERAGE

REMOTE SENSING IN EAST AFRICA

Remote sensing training, user services, and project work support are available through the Regional Remote Sensing Facility, located in Nairobi, Kenya. The Facility is a division of the Regional Centre for Services in Surveying and Mapping, which was established in 1975 by several East African countries under the auspices of the United Nations Economic Commission for Africa.

The Facility offers short courses of about 3 weeks' duration as a service to the East African region. These courses are designed to introduce remote sensing techniques to professional staff in government departments, universities, and resource organizations. Extended courses, lasting several months, are also available. These generally involve 2 weeks of instruction on the Facility's premises, followed by an extended period of project work conducted by individual students in their home countries. All training emphasizes the analysis of Landsat data and is discipline-specific in its approach.

The Facility maintains an extensive reference file of Landsat data that have been acquired over the region, and it supports a variety of image interpretation equipment as well as a photographic laboratory.

Included in the region served by the Facility are Sudan, Ethiopia, Somalia, Uganda, Kenya, Seychelles, Rwanda, Burundi, Tanzania, Zambia, Malawi, Mozambique, Malagasy, Comoro, Mauritius, Zimbabwe, Botswana, Swaziland, and Lesotho.

Readers who are interested in further information on the Regional Remote Sensing Facility, or who wish to apply for admittance to one of the several training courses offered, are invited to write:

Regional Remote Sensing Facility
P.O. Box 18332
Nairobi, Kenya
Telephone: 556400
Cables: Landsat Nairobi

NOW AVAILABLE.... LANDSAT 4 MSS DATA

Landsat 4 MSS data acquisitions beginning with those acquired on September 16, 1982, are now being placed in the EDC data base and are available to the public. Users should be aware that band 4 of these early MSS data is not decompressed (from a brightness value range of 0-63 to a range of 1-127), similar to what has been the case with Landsat 3 MSS band 7 data. Modifications are being made to the Landsat 4 ground processing system, and decompression of band 4 should begin in mid- to late October. During the interim: (1) users of MSS digital data must expect to receive compressed data in band 4, (2) band 4 photographic products will be of very low contrast, and (3) false-color composites will be made using band 3 instead of band 4.

Additional information regarding Landsat 4 MSS products can be obtained by contacting: Landsat Customer Services, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6151.

NEW PUBLICATIONS

Remote Sensing for Resource Management is the title of a book to be published this October by the Soil Conservation Society of America. Written for the resource management professional, this 688-page volume deals with remote sensing applications in the management of land, water, vegetation, soil, and mineral resources. The text takes a "how-to-do-it" approach and stresses procedures and methodologies, making it a good reference source for both the practitioner and students. Orders for this book may be placed with the Soil Conservation Society of America, 7515 N.E. Ankeny Road, Ankeny, IA 50021. The price is $45.

The American Society of Photogrammetry is now taking advance orders for the Second Edition of the **Manual of Remote Sensing.** Publication is scheduled for early 1983. The two-volume set contains nearly 2,400 pages and presents the contributions of over 300 experts in the field. Much of the material is new and covers many recent developments in remote sensing, such as Landsat 4 and SPOT. To reserve a copy, contact the American Society of Photogrammetry, 210 Little Falls St., Falls Church, VA 22046. The price is $99.

An excellent primer on remote sensing principles and applications, emphasizing Landsat, has just been published by NASA under the auspices of its Eastern Regional Remote Sensing Applications Center. The 558-page volume is titled **The Landsat Tutorial Workbook: Basics of Satellite Remote Sensing** by Dr. Nicholas M. Short. It is intended as a self-instructional tool, proceeding from fundamental concepts in remote sensing to the mechanics of image interpretation. A laboratory approach is taken throughout, complete with exercises and answers to the problems posed. Students and professionals needing to prepare for more advanced work in remote sensing will find this book useful. It is available from the Superintendent of Documents, U.S. Geovernment Printing Office, N. Capitol St. between G and H Streets N.W., Washington, D.C. 20052. Reference should be made to GPO Stock No. 033-00-00845-7. The price is $55.

VIDEOCASSETTE SERIES OFFERED BY PURDUE

Purdue University has announced the release of a set of five tutorial videotapes on remote sensing under the general title of **Introduction to Quantitative Analysis of Remote Sensing Data.** Each tape contains a 30-minute program presenting well illustrated aspects of the technology from the perspective of an experienced scientist.

Prepared by the senior research and teaching staff of the Laboratory for Applications of Remote Sensing (LARS), the series includes:

- "The Remote Sensing Information System," by Dr. David A. Landgrebe.
- The Role of Pattern Recognition in Remote Sensing," by Dr. Phillip H. Swain.
- "Correction and Enhancement of Digital Image Data," by Dr. Paul E. Anuta.
- "Special Properties of Soils," by Dr. Marion F. Baumgardner.
- "The Role of Numerical Analysis in Forest Management," by Dr. Roger M. Hoffer.

Each videotape is accompanied by a set of printed notes which reinforce important concepts and provide self-administered tests on the subject being addressed.

Although the level and complexity of these programs are most appropriate for those already familiar with remote sensing concepts and terminology, a mathematical background is not required. They are intended as a follow-on course of instruction for anyone wishing to pursue the field further after an introduction to fundamentals.

The tapes are available in all popular formats: ¾-inch U-matic, ½-inch VHS, or ½-inch Beta I. Non-U.S. video standards—PAL or SECAM—are available by special order.[3] The price of each tape is $250.

An 8-page brochure describing the tapes, or a

[3] U-matic, VHS, Beta 1, PAL, and SECAM are internationally accepted designations referring to the formatting and/or time code emplacement characteristic of certain commercial-grade videotape recordings.

10-minute preview tape which may be borrowed, are also available.

For any of these materials, contact Mr. G.W. O'Brien, Continuing Education Administration, 116 Stewart Center, Purdue University, West Lafayette, IN 47907, telephone: (317) 494-7231.

EDC COURSE ANNOUNCEMENT

From December 6-10, 1982, the EROS Data Center will be offering a training course entitled **The Role of Remote Sensing in a Geographic Information System.** This specialized course will emphasize the contributions of remotely sensed and other kinds of spatial data (including terrain models) to geographic information systems, as well as the types of spatial analyses commonly used for natural resource applications. The course is designed for remote sensing analysts and resource specialists and assumes an understanding of the fundamentals of remote sensing. For more information, contact the Chief, Training and Assistance, Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198.

SYMPOSIA

The Rolla Region Chapters of the American Congress on Surveying and Mapping and the American Society of Photogrammetry have joined forces to co-sponsor a symposium entitled **The Utilization of Automated and Conventional Methods in Surveying, Mapping, and Map Data Applications,** to be held October 13-15, 1982, in Rolla, Mo. The program will include concurrent seminars and demonstration workshops in the areas of surveying, photogrammetry, remote sensing, and automated cartographic applications. For further information, contact Mr. Gary McKeown, Coordinator, ASCM-ASP Symposium, 1400 Independence Road (Mail Stop 601), Rolla, MO 65401, telephone: (314) 341-0928.

The **International Symposium on Remote Sensing of Environment—Second Thematic Conference: Remote Sensing for Exploration Geology** will be held December 6-10, 1982, in Fort Worth, Tex. This symposium is sponsored by the Environmental Research Institute of Michigan and Texas Christian University. Further information is available from Donald R. Morris-Jones, Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, MI 48107, telephone: (313) 944-1200.

The **17th International Symposium on Remote Sensing of Environment,** to be held May 9-13, 1983, in Ann Arbor, Mich., will address state-of-the-art capabilities and techniques leading to a better understanding of remote sensing technology and its effective application. Sponsored by the Environmental Research Institute of Michigan, both conventional sessions and multidisciplinary poster sessions will be offered at this meeting. The call for papers solicits recent research results on ultraviolet, infrared, microwave, acoustic, seismic, and other types of sensors, either singly or in combination. The submission deadline is November 1, 1982. Contributors and other persons interested in attending this meeting may contact the Remote Sensing Center, Environmental Research Institute of Michigan, P.O. Box 8618, Ann Arbor, MI 48107, telephone: (313) 994-1300.

A special emphasis on resource evaluation will be the theme at the **9th International Symposium on Machine Processing of Remotely Sensed Data,** to be held June 21-23, 1983, in West Lafayette, Ind. The meeting is one of a series that has been sponsored every year by Purdue University's Laboratory for Applications of Remote Sensing (LARS). The call for papers solicits research results in such topical areas as scene simulation and modeling, geometric and radiometric preprocessing of data, stratification and sampling, classification algorithms, and digital geographic information systems. Deadline for abstracts is December 17, 1982. Potential contributors and those wishing to attend are invited to contact Mr. D.B. Morrison, Symposium Coordinator, Purdue University/LARS, 1220 Potter Drive, West Lafayette, IN 47906, telephone: (317) 494-6305. Inquiries regarding the technical content of the symposium can be directed to the Symposium Chariman, Dr. Richard A. Weismiller, at the same address.

Hamburg, Federal Republic of Germany, will be the site for an **International Symposium on Hydrological Applications of Remote Sensing and Remote Data Transmission,** to be held August 15-27, 1983. The symposium is sponsored by the International Association of Hydrological Sciences and is co-sponsored by the World Meteorological Organization. It will be one of a number of symposia to be convened as part of the XVIII General Assembly of the International Union of Geodesy and Geophysics. The sessions will cover such topics as precipitation, snow and ice, surface water, soil moisture, ground water, hydrogeology, water quality, coastal and wetlands hydrology, and water resource planning and management. Requests for further information on this meeting may be sent to A. Ivan Johnson, President, International Committee on Remote Sensing and Data Transmission, Woodward-Clyde Consultants, Harlequin Plaza-North, 7600 East Orchard Rd., Englewood, CO 80111.

EDC TRAINING SCHEDULE

Oct. 25-29	**Terrain Analysis: Interpretation of Aerial Photographs and Images** (Sioux Falls, S. Dak.) Contact: Coordinator, Continuing Education Program, Harvard Graduate School of Design, Gund Hall, L-37, Harvard University, Cambridge, MA 02138, telephone: (617) 495-2578.
Nov. 1-5	**Hydrology Information Workshop** (Sioux Falls, S. Dak.) Open enrollment. Contact: Chief, Training and Assistance, Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

Nov. 15-19 **Advanced Geological Workshop** (Sioux Falls, S. Dak.) Open enrollment. Contact: Chief, Training and Assistance, Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

Dec. 6-10 **Role of Remote Sensing in a Geographic Information System** (Sioux Falls, S. Dak.) Open enrollment. Contact: Chief, Training and Assistance, Branch of Applications, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, telephone: (605) 594-6114.

ADDITIONAL TRAINING IN REMOTE SENSING

Sept. 15-Dec. 8 **Remote sensing of Coastal Environment and Marine Resources** (Newark, Del.) Contact: Dr. Vic Klemas, Director, Center for Remote Sensing, University of Delaware, Newark, DE 19711, telephone: (302) 738-2336.

Oct. 4-8 **The Application and Processing of Landsat Data** (Murray, Ky.) Contact: Dr. Neil V. Weber, Director, Mid-American Remote Sensing Center, Murray State University, Murray, KY 42071, telephone: (502) 762-2148.

Oct. 18-22 **Remote Sensing for Global Resource Applications** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington University, Washington, DC 20052, telephone: (202) 676-6106.

Oct. 25-29 **Digital Image Processing of Earth Observation Sensor Data** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington University, Washington, DC 20052, telephone: (202) 676-6106.

Nov. 15-18 **Mapping from Space: Techniques and Applications** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington University, Washington, DC 20052, telephone: (202) 676-6106.

Nov. 15-19 **Synthetic Aperture Radar with Remote Sensing Applications** (Washington, D.C.) Contact: Continuing Engineering Education, George Washington University, Washington, DC 20052, telephone: (202) 676-6106.

Dec. 7-9 **Advanced Geological Remote Sensing** (Washington, D.C) Contact: Continuing Engineering Education, George Washington University, Washington, DC 20052, telephone: (202) 676-6106.

EDC LANDSAT PRODUCTION STATISTICS

	Feb. '82 MSS	Feb. '82 RBV	Mar. '82 MSS	Mar. '82 RBV	Apr. '82 MSS	Apr. '82 RBV	May '82 MSS	May '82 RBV	June '82 MSS	June '82 RBV	July '82 MSS	July '82 RBV	6-Month Total MSS	6-Month Total RBV
Landsat scenes acquired (satellite acquisitions)*	839	260	1,263	465	2,504	626	2,158	544	1,980	391	3,094	463	11,838	2,749
Landsat MSS scenes/RBV subscenes received at EDC	1,147	3,362	945	3,222	1,847	1,744	1,562	1,711	2,540	2,147	3,138	2,009	11,179	14,195
Average time in days from EDC receipt to archive availability	9.7	15.4	4.3	5.9	9.7	6.9	8.0	8.6	18.6	30.9	16.1	26.1	–	–
Average delivery time in days from receipt of order at EDC to shipment														
Standard photographic products	9		10		13		13		15		19		–	
Standard digital products	6		6		12		7		5		7		–	
Landsat photographic frames sold	8,078		5,860		9,076		7,385		6,118		13,637		50,154	
Landsat digital scenes sold	263		280		181		497		421		369		2,011	
TOTAL LANDSAT DOLLAR VOLUME	$224,076		$185,240		$213,641		$262,242		$236,221		$381,674		$1,503,094	

*Figures are revised periodically to reflect updated information received from NASA.

The Landsat Data Users NOTES is published bimonthly in order to present information of interest to the user community regarding Landsat products, systems, and related remote sensing developments. There is no subscription charge; individuals and organizations wishing to receive the NOTES should contact the User Services Section, U.S. Geological Survey, EROS Data Center, Sioux Falls, SD 57198, U.S.A., telephone (605)594-6151.

Comments, corrections, and other inquiries should be directed to:

Editor, Landsat NOTES
U.S. Geological Survey
EROS Data Center
Sioux Falls, SD 57198

U.S. GOVERNMENT PRINTING OFFICE: 1981 664-076/5